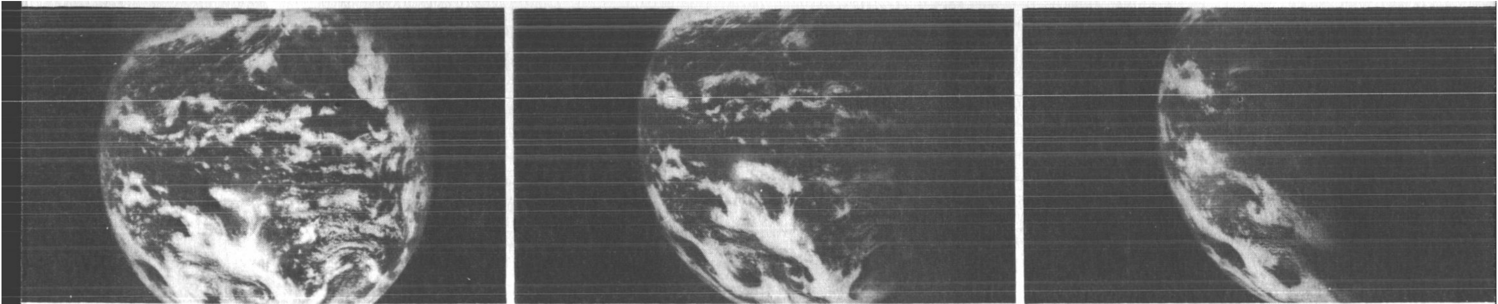
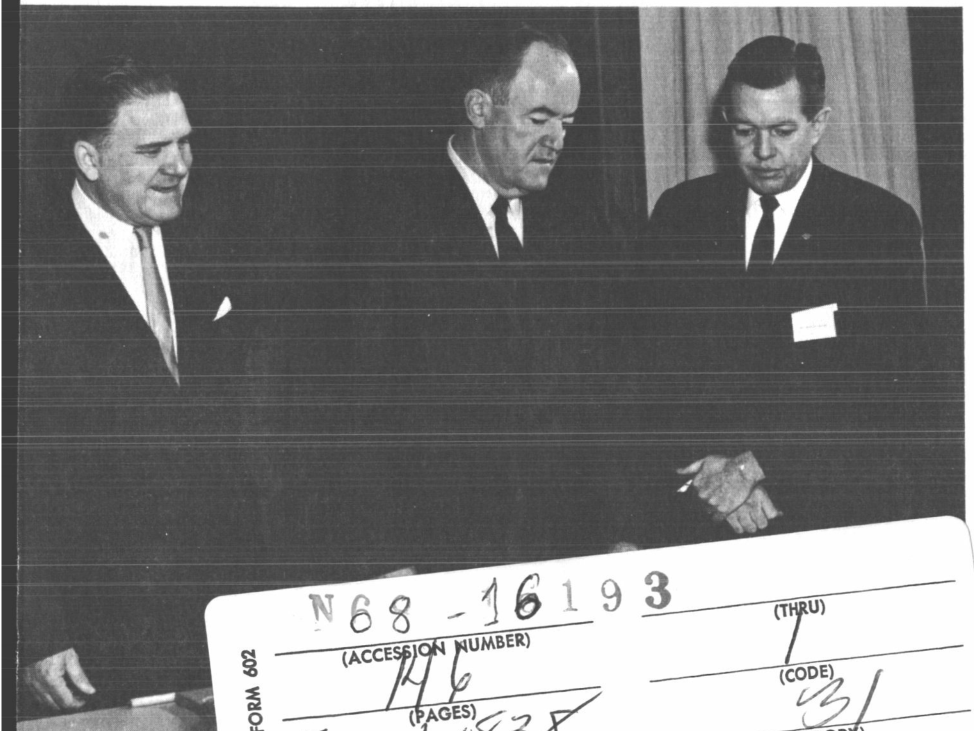
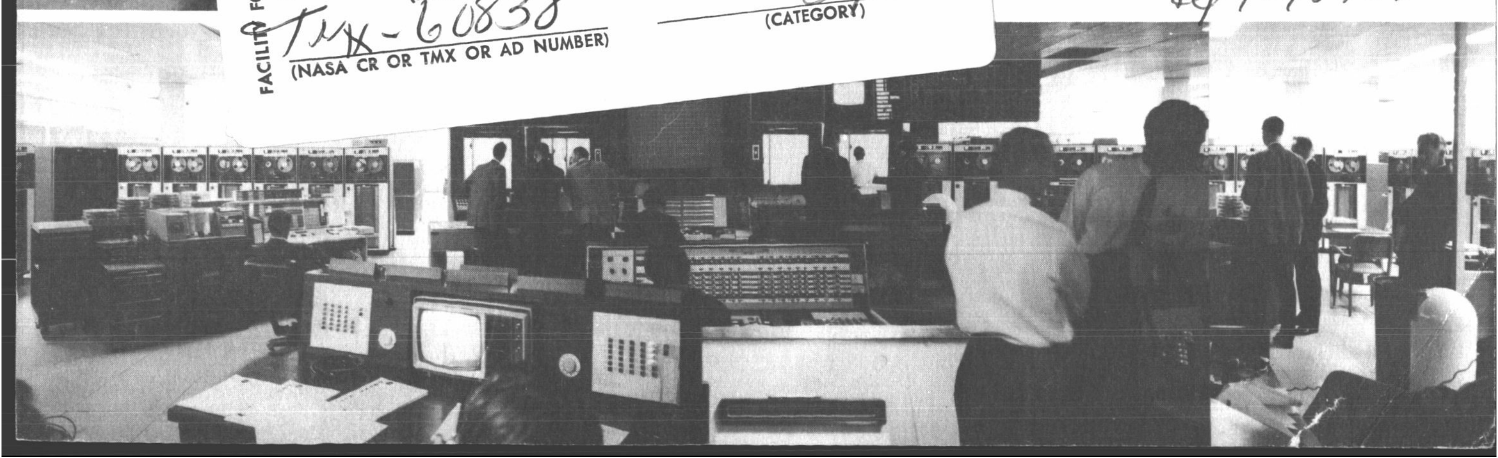


GODDARD '66



A YEAR IN REVIEW
AT GODDARD SPACE
FLIGHT CENTER

NATIONAL
AERONAUTICS
AND SPACE
ADMINISTRATION



HE COVER – Top: First ATS Photos looking at the Earth from an altitude of approximately 22,300 miles ken on December 11, 1966. Center: Vice President Hubert H. Humphrey visits the Center on March 3, 66. He is shown with Dr. John F. Clark, Center Director and NASA Administrator, James E. Webb. ttom: The Goddard Computer Center during the final Gemini Mission, November 11, 1966.

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GODDARD MISSIONS 1966

Launch Date	*Range*	*Vehicle*	*Spacecraft*	*Support*
February 3	ETR	Delta 36	ESSA-I	Mission Responsibility
February 26	ETR	AS 201	Apollo Saturn-IB	Tracking
February 28	ETR	Delta 37	ESSA-II	Mission Responsibility
March 16	ETR	Titan II	GT-VIII	Tracking
April 8	ETR	Atlas/Agena	OAO	Mission Responsibility
May 15	WTR	TAT/Agena	Nimbus II	Mission Responsibility
May 25	ETR	Delta 38	Explorer XXXII	Mission Responsibility
June 1	ETR	Titan II	GT-9	Tracking
June 7	ETR	Atlas/Agena	OGO-III	Mission Responsibility
June 24	WTR	T/A Agena	Pageos	Tracking
July 1	ETR	T/A Delta 39	Explorer XXXIII	Mission Responsibility
July 18	ETR	Titan II	GT-10	Tracking
August 17	ETR	Delta 40	Pioneer VII	Launch Vehicle
August 25	ETR	AS 202	Saturn 202	Tracking
September 12	ETR	Titan II	GT-11	Tracking
October 2	WTR	Delta	ESSA III	Mission Responsibility
October 26	ETR	Delta 41	Intelsat II A Comsat Corp. Project	Mission Responsibility
November 11	ETR	Titan II	GT-12	Tracking
December 6	ETR	Atlas/Agena	ATS-I	Mission Responsibility
December 14	ETR	Delta 42	Biosatellite	Tracking

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INTRODUCTION

GODDARD '66

During 1966, the Goddard Center, successfully launched 47 satellites out of 51 attempts. Eight of the nine Goddard-managed spacecraft put into orbit during the year were classified officially as successes. The one failure occurred in April when the first Orbiting Astronomical Observatory stopped operating after only two days in orbit because of a battery malfunction.

Also, under Goddard's auspices, 158 scientific sounding rockets were launched in 1966. Sixty-seven of these lifted off from sites in other countries: 33 from Canada, 15 from Brazil, five from Pakistan, three from India, two from Ascension Island in the South Atlantic Ocean, and seven from shipboard off the coast of Greece.

Eighty of the 158 sounding rockets carried space research experiments provided by universities, industry, NASA and other governmental agencies, including 13 with experiments provided by scientists of other nations.

Only two launchings out of the 158 total were classified as failures.

Another Goddard-managed project, the Delta rocket, put eight spacecraft into orbit during the year. These included three Environmental Science Services Administration weather satellites, NASA Explorers 32 and 33, both of which were built at Goddard, Pioneer VII, Biosatellite I and the Communications Satellite Corporation's Intelsat II.

At the year's end, Delta's launch record stood at 40 successes out of 43 launch attempts – one of the most impressive in the U.S. space program.

Tracking and Data Acquisition

Tracking and acquiring data from the large number of unmanned scientific and applications spacecraft orbited in 1966 – as well as more than 20 operating spacecraft launched in earlier years – was the task of the Goddard Space Tracking and Data Acquisition Network (STADAN).

At year's end, there were five Space Tracking and Data Acquisition Network (STADAN) stations in the U.S. and nine stations located overseas in eight foreign countries, on every continent except Asia and Antarctica.

During 1966 the Goddard-managed Manned Space Flight Network (MSFN), served four Gemini missions as well as two unmanned checkout Apollo/Saturn flights. The year saw the completion of the Gemini program, however, the MSFN network was already being converted for the Apollo mission, and all stations were in readiness to support the first manned launching in the Apollo program scheduled for early 1967.

Space Science and Applications Programs

During 1966, Goddard's basic mission, remained essentially unchanged. This involved, in addition to the task of operating the STADAN and MSFN tracking networks, an extensive NASA program for the scientific investigation of space as well as the responsibility for

the U.S. applications satellite program. The program also included assisting and supporting satellite programs conducted by Canada, Great Britain, France, Italy and the European Space Research Organization (ESRO).

Two new satellite programs were undertaken by Goddard during 1966: The Small Standard Satellite designed to continue the work of the energetic particles explorer satellite series pioneered by the Center to study the space environment inside the envelope of the earth's magnetosphere. Also the X-ray Explorer, a new satellite series designed to conduct extensive investigations of recently discovered, little understood X-ray sources in space.

Another new program undertaken during 1966 was related to conducting detailed feasibility studies for a "Galactic Probe" spacecraft to fly highly-complex, long-duration missions to other planets in the solar system and eventually to regions outside the system.

At year's end, the Goddard staff consisted of more than 3,800 Civil Service employees, most of whom work at the Center's Greenbelt site. Overall, Goddard's expenditures during the year exceeded more than $400 million.

Other Highlights

Other highlights of 1966 included:

Publication of 656 scientific and technical papers and documents by the Center personnel.

Proof, provided by Explorer XXXIII (Anchored Interplanetary Monitoring Platform), that the earth's magnetosphere extends well beyond the orbit of the moon on the side opposite the sun.

First detailed mapping of the sun-side of the magnetosphere by Orbiting Geophysical Observatory I.

First simultaneous operation of three OGO spacecraft which, collectively through the end of the year, provided more than 300,000 hours of experiment instrument data – more than any other single series of scientific spacecraft.

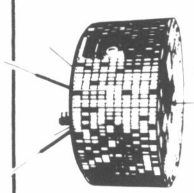
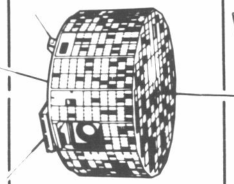
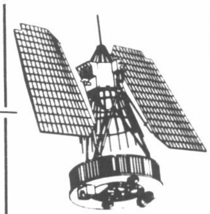
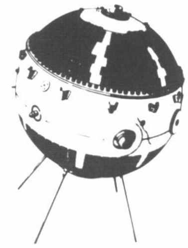
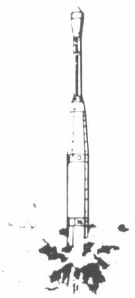
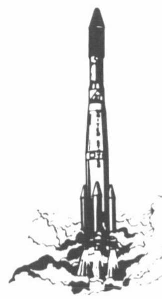
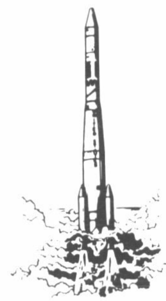
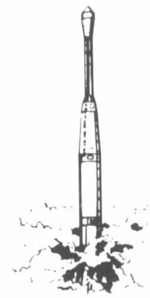
Explorer XXVI (Energetic Particles Explorer-D) completed two full years of almost flawless operation, exceeding by 100 percent its designed lifetime. This satellite provided much valuable data on the Van Allen radiation belts and the space environment inside the earth's magnetosphere.

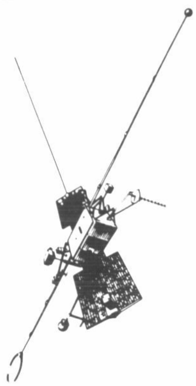
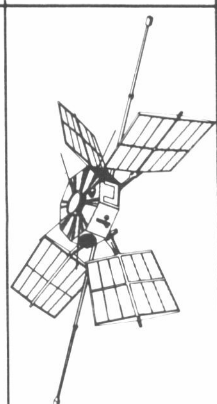
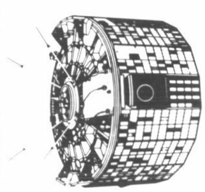
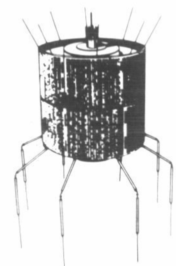
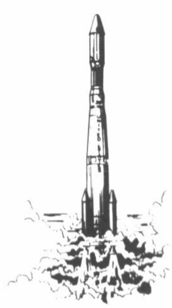
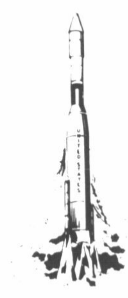
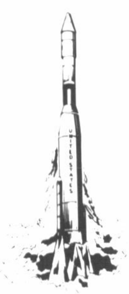
Nimbus II exceeded its six-month operating lifetime. By the end of the year it had transmitted more than 900,000 day and nighttime pictures of global weather, including 16 typhoons and nine hurricanes.

First successful launching, in July, of a sounding rocket system capable of pointing to specific locations in space. During the first flight, the payload, developed at the Center's Astrophysics Branch, Laboratory for Space Sciences, automatically pointed at three different stellar sources. A second successful flight of the system, called STRAP (Stellar Tracking Attitude Positioning System), was accomplished later that year.

A climax to the year was the highly successful first launch of Applications Technology Satellite I. This large, communications-meteorology-scientific satellite, went into a synchronous orbit and immediately began a series of pioneering space experiments. By the end of the year it had produced pictures showing more than 40 percent of the earth's surface; relayed the first two-way voice communications between ground stations and in-flight aircraft; and its microwave repeaters sent color television from Australia to the U.S. and from Japan to the United States.

CONTENTS

FEBRUARY 3	FEBRUARY 28	MAY 15	MAY 25
			
ESSA I	ESSA II	NIMBUS II	EXPLORER XXXII
			
DELTA 36	TADelta 37	THOR/AGENA	DELTA 38

JUNE 6	JULY 1	OCTOBER 2	DECEMBER 6
			
OGO III	EXPLORER XXXIII (AIMP)	ESSA III	ATS I
			
ATLAS/AGENA	TADELTA 39	TADelta 41	ATLAS/AGENA

CHRONOLOGY 1966

EARLY JANUARY

Final functional tests on OAO A-1 were completed. Results of the tests showed that the observatory could be readied for shipment to Cape Kennedy.

EARLY JANUARY

TIROS VII, VIII, IX, and X were providing useful data regularly with TIROS X being the prime source. TIROS IX had been programmed an average of 4 orbits per day during the past 2 weeks. The noise, probably due to arcing in tape recorder electronics, which was evidenced during a period when the satellite was in a total sunlit orbit had disappeared.

EARLY JANUARY

The Operational TIROS-3 spacecraft completed all tests and calibration.

JANUARY 1

Experiments and subsystems of the Explorer XXVI (EPE-D) satellite continued to function normally, some 376 days after launch.

JANUARY 5

A Communications Satellite Corporation memorandum was issued to establish an identification for the various satellite systems. What had been referred to as HS-303 or Early Bird series was identified as INTELSAT I. The HS-303A Blue Bird or Apollo Communications support satellite series was identified as INTELSAT II.

JANUARY 10

The NASCOM voice data facility control system at Canberra, Australia was installed. This switching center was to be used for regeneration of high speed data from Carnarvon and Woomera to GSFC. It also was to be used to transmit high speed data from the computers located at Canberra to GSFC.

JANUARY 12

Dock trials on the Apollo tracking ship "Vanguard" were accomplished.

JANUARY 12

The first meteorological sounding rocket launchings to be conducted from North and South America on the same day under a coordinated program were successfully accomplished. Under a NASA-Brazilian Space Commission (CNAE) experimental program, the South American launching was performed at Natal and the North American launching took place at NASA's Wallops Station, Va. Boosted Dart rockets carrying chaff payloads were launched from both Natal and Wallops Island.

The Natal launching was the first of a series of 32 which CNAE expected to conduct this year as part of the Inter American Experimental Meteorological Sounding Rocket Network (EXAMETNET). Brazil, Argentina and the U.S. were cooperating in this network which eventually was to include a series of stations in a north-south chain through the Western Hemisphere. From these stations, coordinated sounding rocket launchings were to be conducted to obtain experimental data on hemispheric weather patterns.

JANUARY 14

An agreement for cooperative meteorological sounding rocket experiments had been reached by the Spanish Comision Nacional De Investigacion Del Espacio (CONIE) and the NASA. Purpose of the project was to obtain synoptic information on wind, temperature, and pressure at altitudes between 18 and 36 miles.

Sixteen boosted-Dart and Arcas type sounding rockets carrying chaff (shredded tinfoil) or instrumented payloads were to be launched from a range in Spain to be operated by the Institute Nacional de Tecnica Aeroespacial (INTA).

MID JANUARY

TIROS OT-3 has completed all tests and was at ETR.

MID JANUARY

The erection of the Unified S-Band antenna at MILA, Fla. was complete. The installation of the Unified S-Band antenna was started at Guaymas, Mexico. The preliminary checkout of the Bermuda USB was in progress.

MID JANUARY

D. Freeman has been named as the WRE Station Director at Cooby Creek, Australia which was to serve the Applications Technology Satellite program.

MID JANUARY

TIROS X continued as the prime source of data for Environmental Science Services Administration (ESSA). TIROS IX was being programmed on 4 orbits per day to supplement TIROS X data. TIROS VII and VIII were being interrogated minimumly for housekeeping only.

JANUARY 16

The OAO A-1 Satellite arrived at Cape Kennedy late in the evening. No problems were encountered with permits or transportation arrangements. However, mechanical trouble on the trailer delayed the convoy in Georgia. One wheel came off the trailer, but the inside wheel stayed on. No damage to the satellite was sustained.

JANUARY 19

The Goddard Launch Phase Simulator arm structure arrived at the site for installation in Building 15.

JANUARY 20

TOP GODDARD CONTRACTORS SINCE 1961

1.	RCA	$197M
2.	TRW	168M
3.	Bendix	158M
4.	GE	128M
5.	Grumman	94M
6.	Hughes	81M
7.	Collins Radio	56M
8.	IBM	52M
9.	Sperry Rand	38M
10.	Ball Bros. Res.	34M
11.	Fairchild Hiller	27M
12.	Radiation, Inc.	25M
13.	EMR	21M
14.	Philco (Ford)	17M
15.	Keltec Industries	15M
16.	WTA	15M
17.	Norair	14M
18.	Kollsman	14M
19.	Motorola	14M
20.	Gen. Dynamics	11M
	Other Federal Agencies, i.e. DOD	194M
	Foreign Govts. (Australia, U.K.)	39M
	Universities and non-profits	50M
	Total of all since 1961	$1.9 Billion

JANUARY 21

The IBM 360/75J Super-Speed Computer System was delivered to the Goddard Institute for Space Studies, Oxford Building, New York City.

JANUARY 24

NASA announced contract negotiations with TRW Systems, Redondo Beach, Calif., to convert the propotype Orbiting Geophysical Observatory (OGO) into a flight observatory. Negotiations may also include a possible option to fabricate an additional flight observatory.

TRW Systems was the prime contractor to the Goddard Space Flight Center, for the Orbiting Geophysical Observatory Program. The contract was expected to total for about $9,000,000.

JANUARY 26

Seventy-five two way channels (73 telephones and two records) of Intelsat I (Early Bird) were in operation. There were indications that there had been one or more cell failures in the spacecraft batteries. This was not considered to be a serious matter since the primary source of power for the communications repeater was the solar plant.

JANUARY 27

The French FR-1 spacecraft completed 52 days of successful operation.

JANUARY 29-30,

Builder's trials were held on the "Vanguard" Apollo Tracking Ship. Approximately 600 deficient items were noted by the contractor and government personnel during the trials. Bad weather caused the ship to stay out three nights rather than the one that was planned.

JANUARY 28

Construction of Meteorological Systems Development Laboratory—Building No. 21 (Arthur Venneri Company contractor) was 99% complete and section C became available for beneficial occupancy.

JANUARY 30—FEBRUARY 2

The "Blizzard of '66" decended during this period and was completely "repulsed." All operational support schedules and related functions were accomplished on time, in spite of a wild and drifting snow. The Goddard personnel assigned to the NETCON/OPSCON support area were at their posts.

LATE JANUARY

The Goddard Road Interchange with Baltimore-Washington Parkway (Dewey Jordan, Inc.) was opened to two-way traffic.

LATE JANUARY

The second joint working group meeting (JWGM) of phase III of the San Marco II satellite project was held in Rome, Italy.

The schedule was geared toward a late '66, early '67 launch of the coast of Kenya.

Essentially, the spacecraft (San Marco B) will be the same as San Marco I with refinements. The circuits were to be more reliable, less complex, and consume less power. The operative lifetime was conservatively estimated at 5 months. Components were being assembled on the prototype payload structrure.

The launcher, mechanical ground support equipment, and shelter presently in transit to LaSpezia, the Italian Naval Shipyard where the launch platform was located. The electrical GSE such as the blockhouse control consoles, was being built by Italian crews at Wallops Island and at Rome.

The platform in LaSpezia was inspected. It was being modified to accept various equipment such as the launcher, shelter and power-generating equipment. The platform was scheduled to be towed to Mombasa during the latter part of this month. Modifications were to be completed there.

FEBRUARY 3

Bid opening for the NASA Space Science Data Center construction contract was held. Subsequently, two bidders claimed errors in their bids.

FEBRUARY 3

High velocity winds of 151 knots at 40,000 feet precipitated a one day delay in the launch of ESSA 1 Weather Satellite (OT-3), Delta 36. The winds were also severe the following day decreasing just prior to launch to acceptable limits. The OT-3 was launched at 0741Z. Orbital elements were:

Period (min.)	100.22
Apogee (n.mi.)	452
Perigee (n.mi.)	378
Inclination (deg.)	97.893
Eccentricity	.0096

FEBRUARY 4

The Canberra Australian switching center teletype technical control facility became operational.

FEBRUARY 4

Vice President Hubert H. Humphrey attended a ceremony marking the successful launching of the Environmental Science Service Administration's ESSA-1, the Weather Bureau's first operational weather-watching satellite. First pictures made by ESSA-1, launched by NASA on February 3, at Cape Kennedy, were released and two NASA and one ESSA project officials received NASA Exceptional Service medals.

The Vice President lauded the spirit of cooperation between NASA and the Department of Commerce, pointing out that "science leaves no room for jurisdictional disputes."

Receiving the NASA medal from the Vice President for their part in the successful ESSA-1 launching were Dr. Morris Tepper, NASA's director of meteorological programs; Herbert I. Butler, NASA's Goddard Space Flight Center's chief of operational satellites; and David S. Johnson, ESSA Environmental Satellite Center director.

FEBRUARY 14

The Goddard Library moved to its new quarters from Bldg. 1 to Bldg. 21.

MID FEBRUARY

ESSA-1 continued to provide approximately 500 pictures per day. TIROS VII, VIII, IX, and X were capable of providing good quality data. However, programming had been reduced to a minimum primarily for power consumption and evaluation.

TIROS IX was programmed to increase coverage in areas which the frequency of ESSA-1 pictures were reduced to "blind orbit" readout requirements.

FEBRUARY 16-18

Goddard's NASCOM participated in Apollo AS201 simulations.

FEBRUARY 17

A $1,491,600 contract was awarded to Equitable Construction Co. of Arlington, Va. for construction of a NASA Space Science Data Center at Goddard.

FEBRUARY 18

Twenty-five scientific experiments for the sixth Orbiting Geophysical Observatory (OGO-F) were selected.

OGO-F investigations was to provide detailed information on characteristics of the Earth's outer atmosphere; ultraviolet emissions from the atmosphere and space; characteristics of the auroral zones; the earth's magnetic field; whistlers and very low frequency radio noise; and solar and galactic cosmic rays.

OGO-F scientific experiments and their experimenters are:

1. Microphone Density Gage—Dr. Gerald W. Sharp and Ted J. Crowther, Lockheed Missiles and Space Co., Sunnyvale, California.

2. Electron Temperature and Density Measurements—Dr. Andrew F. Nagy of the University of Michigan at Ann Arbor and Larry H. Brace, Goddard Space Flight Center, Greenbelt, Md.

3. Ionospheric Duct Detector—Dr. William B. Hanson and Thomas W. Flowerday, Graduate Research Center of the Southwest, Dallas, Texas.

4. Neutral Atmospheric Composition—Carl A. Reber and Dan N. Harpold, Goddard Space Flight Center, and George R. Carignan and David R. Taeusch, University of Michigan.

5. Atmospheric Ion Concentration and Mass—Robert A. Pickett, Harry A. Taylor, Jr., and Merritt Pharo of the GSFC.

6. Ion Mass Spectrometer—Dr. William B. Hanson and Thomas W. Flowerday, Graduate Research Center of the Southwest.

7. Energy Transfer Probe—Daniel McKeown and Dr. H. R. Poppa, General Dynamics/Convair, San Diego, California.

8. Solar X-Ray Spectrometer—Robert W. Kreplin, Dr. C. Stuart Bowyer, Dr. Talbot A. Chubb, and Dr. Herbert Friedman, Naval Research Laboratory.

9. Solar Ultraviolet Radiation Flux (300-1200 Angstroms)—(investigator to be selected).

Gale-force winds coat the buildings and light poles of Philadelphia with ice during last week's blizzard.

Miami's Bay Biscayne is lashed by the 100 mile-an-hour winds in recent tropical hurricane.

NOW THE WORLD WILL GET EARLY WARNING OF EVERY MAJOR STORM FROM A NEW RCA-BUILT ESSA SATELLITE

With the launching of ESSA 1* last week, the U. S. Government took the first step towards providing a constant, complete daily world-wide weather observation. This means early storm warnings—sometimes as much as four or five days in advance.

ESSA 1, developed by RCA, is the eleventh of the TIROS weather satellites – the nation's most successful unmanned satellite program. This is an operational version of TIROS, which provided vital weather support data for Ranger, Mercury and Gemini missions. TIROS satellites have sent to earth over 600,000 weather pictures resulting in more than 4,000 storm bulletins—saving lives and property.

When NASA later launches ESSA 2, it will carry automatic picture transmission cameras to provide local weather pictures to desk-size receiving stations at more than sixty locations now in existence around the world—and to hundreds more that will be installed in the next few years. The heart of the ESSA 2 system uses over 400 integrated circuits.

Now RCA Solid Integrated Circuits are being built into the sound systems of some RCA Victor color and black-and-white television sets. Integrated Circuits, the latest advance over handwiring, provide improved performance, reduced power requirements, and longer life... truly Space Age reliability.

**The ESSA 1 satellite was built by RCA for the Environmental Science Services Administration, Department of Commerce, under the direction of the National Aeronautics and Space Administration.*

COME INTO THE SPACE AGE WITH RCA

RCA

THE MOST TRUSTED NAME IN ELECTRONICS

COMPARISON GROWTH OF NASA'S DOUGLAS-BUILT DELTA

DELTA		DM-19 (Douglas Model)	*DSV-3A (Douglas Space Vehicle)	DSV-3B	DSV-3C	DSV-3D	DSV-3E
FIRST STAGE							
Height		65'	59'8"	59'8"	59'8"	59'8"	59'8"
Diameter (maximum)		8'	8'	8'	8'	14'2" w/solids	14'2" w/solids
Weight (total fueled)		106,389	107,774	107,236	107,774	135,920	135,958
Engine		Rocketdyne MB-3 Block I	MB-3 Block I	MB-3 Block I	MB-3 Block II	MB-3 Block III	LOX & RP-1 MB-3 Block III
Thrust (2 – 1,000 lb. verniers)		152,000	172,000	172,000	172,000	332,000	332,000
Burn Time		160 sec.	146 sec.	146 sec.	146 sec.	149 sec.	149 sec.
Guidance		Autopilot BTL 300	Autopilot BTL 300	Autopilot BTL 600	Autopilot BTL 600	Autopilot BTL 600	Autopilot BTL 600
SECOND STAGE							
Height		17'8"	17'8"	20'8"	20'8"	20'8"	17'3"
Diameter (maximum)		32"	32"	32"	32"	32"	55"
Weight (total fueled)		4,713	4,713	6,048	6,048	6,048	13,058
Engine		Aerojet AJ10-118	AJ10-118	AJ10-118A	AJ10-118A	AJ10-118A	AJ10-118A
Thrust		7,575	7,575	7,575	7,575	7,575	7,614
Burn Time		155 sec.	115 sec.	170 sec.	170 sec.	170 sec.	385 sec.
Guidance		DAC Flight BTL 300	Controller BTL 300	BTL 600	BTL 600	BTL 600	BTL 600
THIRD STAGE							
Height	Bulbous Low Drag	9'7" 10'6"	9'7" 10'6"	9'7" 10'6"	9'7" 10'6"	9'7" 10'6"	18'8"
Diameter	Bulbous Low Drag	48" 33"	48" 33"	48" 33"	48" 33"	58" 33"	65"
Weight	Bulbous Low Drag	725 675	725 675	725 675	792 742	795 745	1140
Motor		ABL X-248-A5	ABL X-248	ABL X-248	ABL X-258	ABL X-258	ABL X-258
Motor Weight		515	515	515	580	580	580
Thrust		2,760	2,760	2,760	6,193	6,193	6,193
Burn Time		40 sec.	40 sec.	40 sec.	23 sec.	23 sec.	23 sec.
Guidance		spin stabilized	spin stabilized	spin stabilized	spin stabilized	spin stabilized	spin stabilized
Weight of spacecraft in 500 n. mile orbit		450	575	700	875	1,000	1,100

10. Solar Ultraviolet Energy Survey (1800-3100 Angstroms)—Dr. Victor H. Regener, University of New Mexico, Albuquerque, N.M.

11. Line Shape of Solar Lyman-Alpha Radiation—Prof. Jacques E. Blamont, University of Paris, France.

12. Celestial Distribution and Spectral Character of Lyman-Alpha Radiation—Dr. Malcolm A. Clark, Dr. David D. Elliot, and Paul H. Metzger, Aerospace Corp., and Dr. Guido Munch, California Institute of Technology, Pasadena, California.

13. Ultraviolet Photometric Measurements of Atomic Oxygen and Hydrogen—Dr. Charles A. Barth and Jeffrey B. Pearce, University of Colorado at Boulder and Edward F. Mackey, Packard-Bell Electronics, Pasadena, California.

14. Airglow and Aurora—Prof. Jacques E. Blamont, University of Paris.

15. Low Energy Auroral Particles—Dr. David S. Evans and Donald E. Stilwell, GSFC.

16. Trapped and Precipitating Electrons—Dr. Thomas A. Farley and Mac C. Chapman, University of California at Los Angeles.

17. Trapped and Precipitating Electrons—Dr. Donald J. Williams and Dr. James H. Trainor, GSFC.

18. Neutron Monitor—Dr. John A. Lockwood and Dr. Edward L. Chupp, University of New Hampshire at Durham.

19. Low Energy Solar Cosmic Rays—Andrew J. Masley and Dr. Paul R. Satterblom, Douglas Aircraft Co., Santa Monica, California.

20. Solar and Galactic Cosmic Rays—Dr. Edward C. Stone and Dr. Rochus E. Vogt, California Institute of Technology.

21. Magnetic Field Measurements—Dr. Joseph C. Cain, Winfield H. Farthing, and Dr. Robert A. Langel, GSFC.

22. Search Coil Magnetometer—Dr. Edward J. Smith of NASA's Jet Propulsion Laboratory and Dr. Robert E. Holzer of UCLA.

23. Electric Field Measurements—Dr. Thomas L. Aggson and Dr. James P. Heppner, GSFC.

24. Very Low Frequency Polarization and Wave Normal Direction—Dr. Robert A. Helliwell and Dr. Robert L. Smith, Stanford University, Palo Alto, California.

25. Whistler-Mode Waves from Audio to Broadcast Frequencies—Prof. Thomas Laaspere and Prof. Millett G. Morgan, Dartmouth College, New Hampshire.

FEBRUARY 21

Systems integration tests between the London Switching Center and Goddard were begun. These tests verified the operation of the London Communications Processor hardware and software.

FEBRUARY 28

The "Vanguard" Apollo Instrumentation Ship was officially accepted by the Navy.

FEBRUARY 28

Bids were opened for construction of Stadan facilities expansion at the Ulaska Tracking Station near Fairbanks, Alaska. C & R Construction Company of Seattle, Washington was the apparent low bidder with a gross figure of $1,196,000.00.

FEBRUARY 28

OT-2, ESSA-2, was successfully launched. The Delta 37 vehicle performance was nominal and the basic orbit elements were as follows:

Apogee altitude (n.mi.)	768
Perigee altitude (n.mi.)	731
Inclination (deg.)	101.0
Period (min.)	113.6

MARCH 1

The selection of three companies was announced for negotiation of parallel six-month feasibility studies of missions for possible second generation Applications Technology Satellites (ATS).

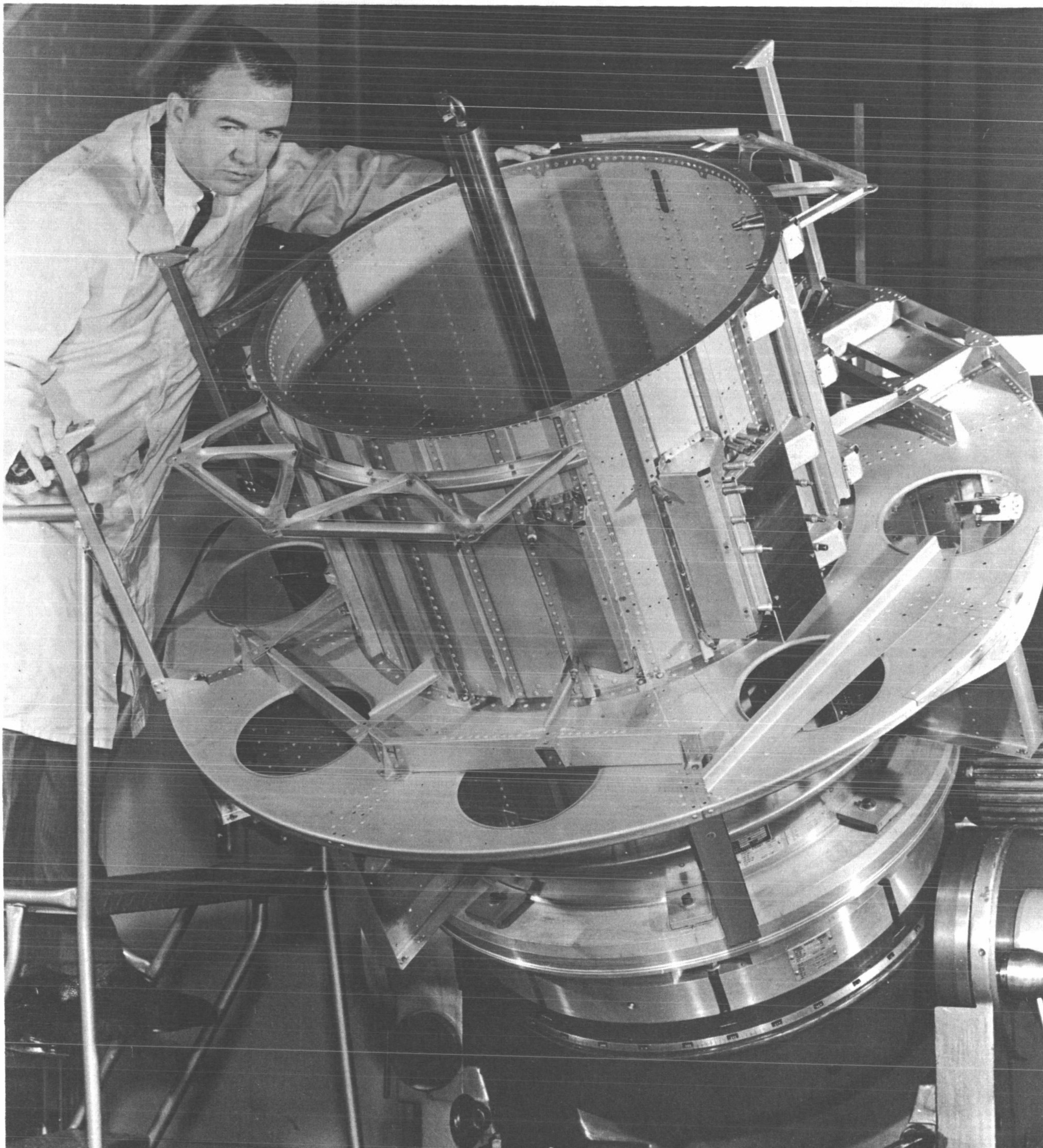
Contractors were Fairchild Hiller, Rockville, Md.; General Electric Co., Valley Forge, Pa.; and Lockheed Missile and Space Co., Sunnyvale, Calif. When negotiations were completed, it was expected the contracts would total about $450,000 or $150,000 each.

The studies were designed to give NASA a sound basis for consideration of a follow-on to the current ATS program for possible flight in the 1969-70 period.

Proposed spacecraft studies included: a. A large (30 feet or more) erectable parabolic antenna; b. Long-lived, high accuracy (one-tenth of a degree) stabilization techniques; c. High gain, multibeam phased array antenna capable of generating four pencil beams, two for transmitting and two for receiving; d. Precision radio interferometer which can be used to determine the attitude of the satellite or the direction of another radio source on Earth or in space.

MARCH 3

Vice President Hubert H. Humphrey accompanied by NASA Administrator James C. Webb and Edward Welch, Exec. Sec. of the National Aeronautics and Space Council visited the Center. Dr. John F. Clark, Acting Director, and spokesmen for the center's scientific and engineering missions briefed the party.

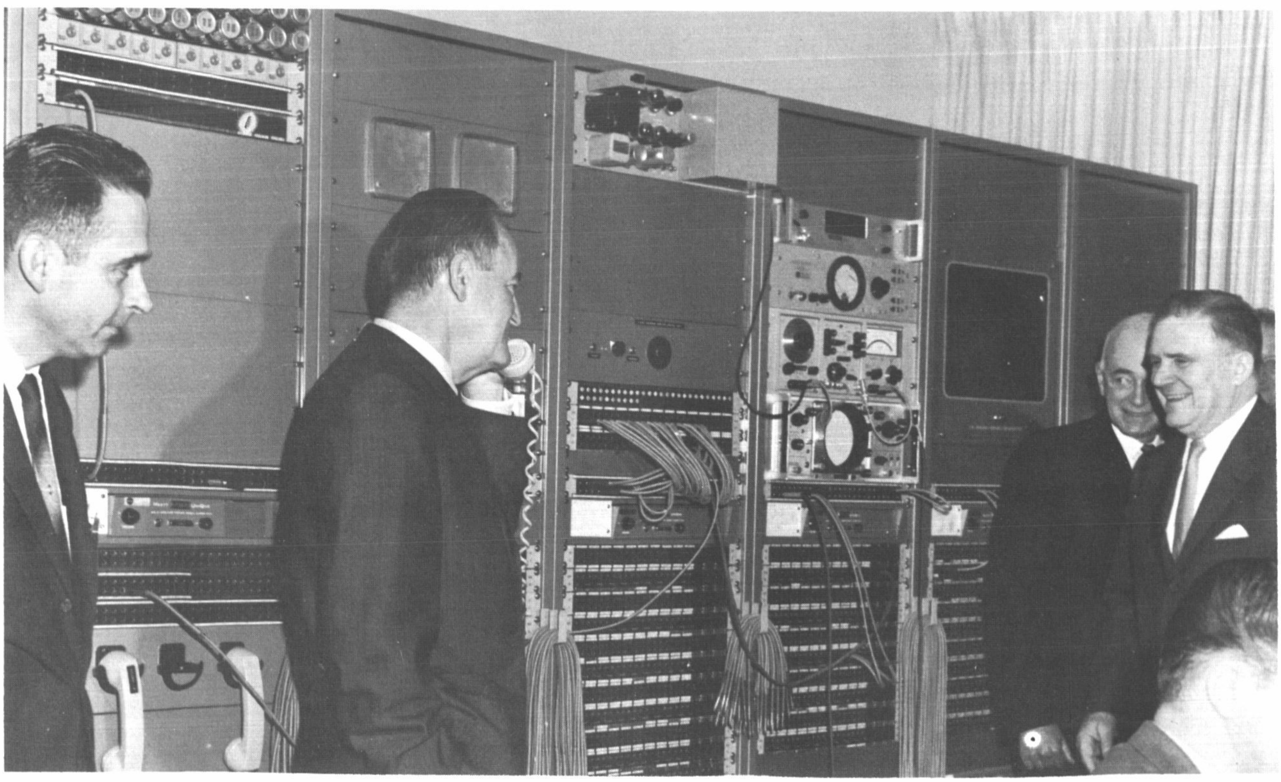


Testing of the spin stabilized Applications Technology Satellite. Only the basic framework is shown here partly assembled.

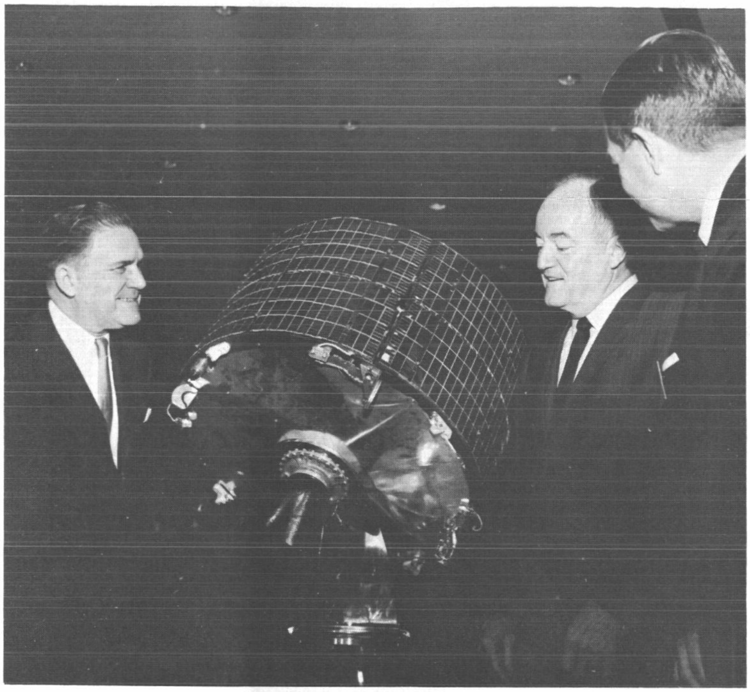
MARCH 3

Vice President Hubert H. Humphrey visits Goddard Space Flight Center.

Discussing NASA's worldwide tracking operations. Goddard Director, Dr. John F. Clark, NASA Administrator, Mr. James E. Webb, Mr. Humphrey, Mr. Ozro Covington, Deputy Assistant Director for Tracking and Data Systems, Goddard Space Flight Center.

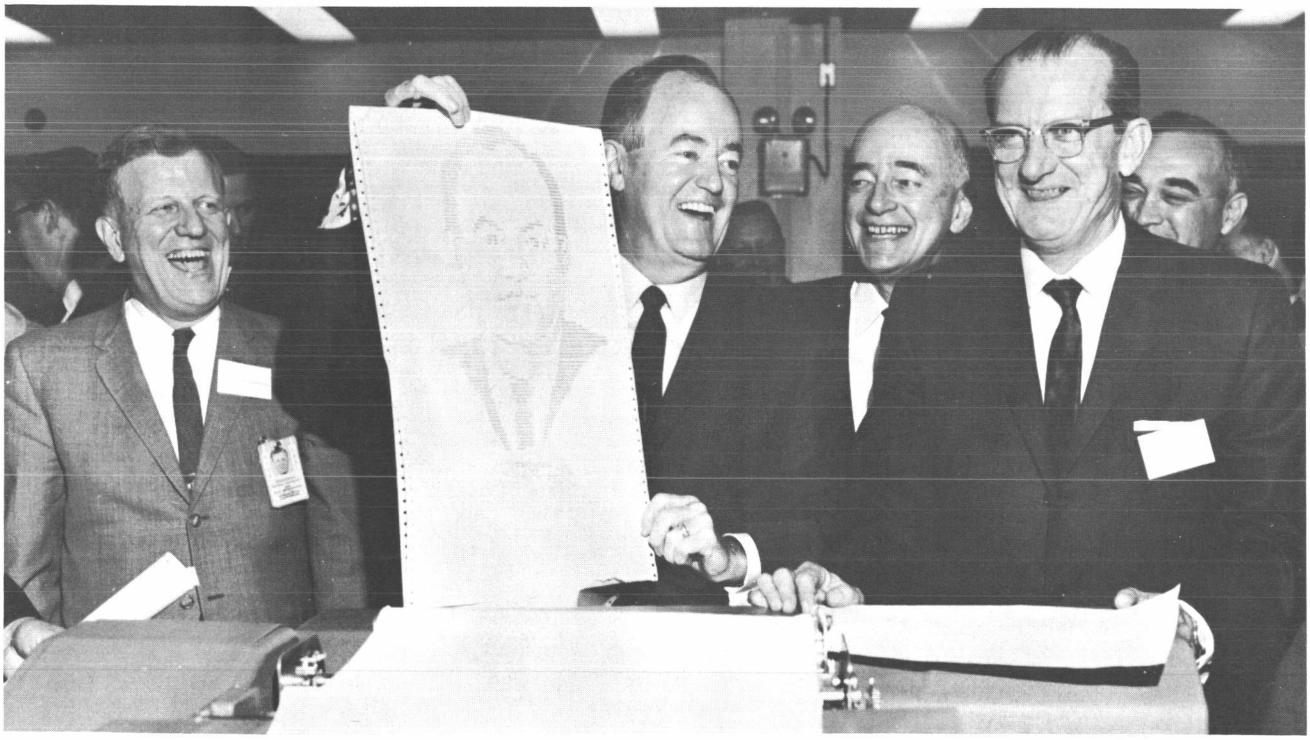


Vice President Humphrey calls NASA's Australian Tracking Station.



NASA Administrator Webb, Mr. Humphrey and Dr. Clark examine the Syncom Communications Satellite.

Dr. John W. Townsend, Jr., Deputy Director (right) briefs the Vice President and his party.



Goddard computers print Vice President's picture while Assistant Director Eugene E. Wasielewski (left), Mr. Ed Welsh, Executive Secretary, National Aeronautics and Space Council and Mr. Covington (right) look on.

EARLY MARCH

The OAO A-1 satellite was mounted on the pallet and encapsulated within the shroud. It was in the clean room at the Cape Kennedy AE hangar undergoing the last functional test prior to being transported to launch complex 12.

EARLY MARCH

Engineering and fabrication of the Interim Voice/Data Patching Facility for Guam was complete.

EARLY MARCH

At the NASA Canberra Communications Switching Center, equipment installation was completed, with the exception of the Univac 418 CP automatic message switching system.

EARLY MARCH

OGO-II, and official failure, was sufficiently successful to operate at least 15 different experiments 100% of the time.

EARLY MARCH

IMP I launched November 26, 1963 was predicted to re-enter on March 10, 1966.

EARLY MARCH

TIROS XI (ESSA-1) was providing global coverage regularly. TIROS IX was supplementing the data on several orbits. TIROS VII, VIII, and X was capable of providing good data but programming had been reduced to minimum.

MARCH 7

NASA received proposals from eight firms for study of feasibility and preliminary design for an Orbiting Data Relay Satellite System.

The successful bidder will receive a six-month fixed price contract for a study to determine the characteristics of a system of ground stations and of data relay satellites in synchronous earth orbit above the equator. Data transfer between spacecraft and NASA mission control centers would be speeded through linking spacecraft directly with central ground stations through data relay satellites.

Eight corporations have submitted proposals for study of the feasibility and required characteristics of the Orbiting Data Relay Satellite System: Booz-Allen Applied Research, Inc., Bethesda, Md.; General Electric Co., Syracuse, N.Y.; Hughes Aircraft Co., El Segundo, Calif.; Radio Corp. of America, Princeton, N.J.; Systems Sciences Corp., Falls Church, Va.; and TRW Systems, Redondo Beach, Calif.

This system could provide for continuous contact with the spacecraft. Signals transmitted from the spacecraft could go directly to the nearest orbiting data relay satellite and thence to a ground station. At present, contact is broken when the spacecraft leaves a ground

STATUS OF OPERATING TIROS SPACECRAFT
As of March 1, 1966

Spacecraft	*Launch Date*	*Days in Orbit*	*Working Sensor*	*Interr./day; Purpose*	*Central Picture Taking Latitude*	*Equator Crossing (local time)*	*Spin-Rate (rpm) Remaining Rockets*
VII	6/19/63	985	Camera 1 (Camera 2 intermittent)	1 orbit for attitude control and power consumption	10° N	–	6.40; 0
VIII	12/21/63	799	Camera 1	1 orbit for attitude control and power consumption	25° N	–	10.07; 2
IX	1/22/65	401	Camera 2	1 orbit for attitude control and power consumption	–	1:58 p.m.	9.85; 5
X	7/2/65	241	Camera 1	3 orbits to supplement ESSA-1	10° S	–	11.55; 5
ESSA-1	2/3/66	25	2-TV cameras	14 orbits for global coverage	–	2:10 p.m.	9.70; 5
ESSA-2	2/28/66	1	2-APT cameras	local readout	–	8:42 a.m.	10.90; 2

Professor Edward Teller, right, with Jaylee Burley, chairman of the Goddard Scientific Coloquia Committee, Dr. Theodore Northrop, second from left, and Dr. Wilmot Hess. Dr. Teller, renowned nuclear physicist, addressed a Goddard Colloquium during March 1966.

station's line of vision and is not renewed until the spacecraft comes in view of the next station below its orbit.

The data relay satellite could fill the gap between stations and result in continuous contact. It could also greatly reduce the number of geographical locations required for data acquisition stations.

The system could provide two-way voice communications as well as high speed data flow.

The kinds of space flight projects that might be supported by such a system would be (1) manned spacecraft in earth orbit, (2) unmanned spacecraft in earth orbit, (3) deep space missions, manned or unmanned, during earth orbit and early trajectory.

The control centers of NASA's three tracking and data acquisition networks which could be linked to spacecraft through the Orbiting Data Relay Satellite System are:

Mission Control Center, Manned Spacecraft Center, Houston Texas for the Manned Spaceflight Network;
Operations Control Facilities, Goddard Space Flight Center, Greenbelt, Md., for STADAN, the unmanned spacecraft network;
Space Flight Operations Facility, Jet Propulsion Laboratory, Pasadena, California, for the Deep Space Network.

A necessary part of such a system is the capability of deploying a high gain antenna in space. The technology definition for this capability will be included in the NASA advanced study program for the Applications Technology Satellite No. 4 (ATS-4).

MARCH 8

OAO simulated launch was performed in real time to check communications at all stations.

MARCH 9

Site clearing operations for new NASA Space Science Data Center got underway.

MARCH 13

Lightning struck the communications receiver and Gemini vans at Madagascar damaging equipment. Station and local communications personnel restored operations in sufficient time for final GT-8 simulations and mission participation.

MARCH 14

The practice of furnishing the U.S. press and USIA with the predictions of Echo I and Echo II orbits was discontinued due to heavy demands upon the Center's computer capability.

MID MARCH

A Goddard report on communication satellites for Apollo missions was completed.

MID MARCH

The Operations Control Center (OPSCON) participated in an OAO launch simulation and supported 294 real-time operations.

MARCH 15

TIROS VII completed 1,000 days of good operation having traveled 14.786 orbits.

MARCH 16

GTA-8

The Data Operations Branch provided computing support for GT-8. The Atlas Agena lifted off at 15:00:03 GMT from Cape Kennedy Launch Complex 14 on an azimuth of 84.4 degrees. It was a perfect insertion into a circular 160 n.m. orbit. At 16:41:02 precisely on time the GT-8 spacecraft on the Titan II booster executed a nominal launch from Cape Kennedy Launch Complex 19 into an 86/146 n.m. elliptical orbit.

Just prior to the docking maneuver warnings of solar flare activity were received from both the Lima, Peru and Halealakea, Hawaii observatories. These flares produced no obvious detrimental effect to HF communications.

Rendezvous and a hard lockup occurred over the Rose Knot Victory in the South Atlantic at approximately 6:10 p.m. EST as planned. After lockup it appeared a rolling mode developed which crosscoupled into pitch. It appeared this motion could not be controlled for some unexplained reason and the astronauts were forced to use fuel from the reentry control system. The spacecraft was uncoupled from the Agena and the decision to reenter in revolution 7 recovery area (7-3) in

TIROS/ESSA
STATUS OF OPERATING SPACECRAFT
As of March 15, 1966

Spacecraft	Launch Date	Days in Orbit	Working Sensors	Total Pictures	Interr/day; Purpose	Central Picture Taking Latitude	Equator Crossing-Wheel (local time)	Spin Rate (rpm); Rockets Remaining
TIROS VII	6/19/63	1,000	Cam. 1 (Cam. 2 inter-mittent)	122,916	1 orbit for attitude control and power consumption	0°	–	6.32; 0
TIROS VIII	12/21/63	814	Cam. 1	97,722	1 orbit for attitude control and power consumption	30° S	–	9.72; 2
TIROS IX	1/22/65	416	Cam. 2	71,130	1 orbit for attitude control and power consumption	–	1:05 pm	9.56; 5
TIROS X	7/2/65	256	Cam. 1	64,919	3 orbits to supplement ESSA-I	10° S	–	11.42; 5
ESSA-1	2/3/66	40	Two TV Cameras	18,592	14 orbits for global coverage	–	2:16 pm	9.90; 5
ESSA-2	2/28/66	16	Two APT Cameras	1,245	local readout	–	8:40 am	10.97; 2

Grand total of all TIROS pictures—632,225

the Pacific was made about 7:05 p.m. EST. The time to fire of 02:45:49Z was based on tracking data from Hawaii, Pretoria, and Ascension. Retrofire was nominal, the lift profile was nominal and the spacecraft landed on target at $\phi = 25.25°$ N, $\lambda = 136°$ E.

When the decision was made to have Gemini 8 reenter, the domestic and overseas common carriers were advised that an emergency condition had arisen. They immediately took the necessary steps to provide circuits with maximum protection against a possible outage or degradation of service. Also, upon request of the MCC Houston, a voice circuit via the NASCOM facilities from the DOD Recovery Control Center at Kunia, Hawaii was extended to the MCC for direct coordination.

Message traffic switched by the GSFC Communications Processors was considerably higher during passes across the U.S. than during previous manned missions because of the dual vehicles. The greater number of broadcast messages at times caused up to 15 minute delays on 60 Word Per Minute Teletype circuits.

Splash occurred approximately 03:23Z or 10:23 p.m. EST. Goddard continued the track of the Agena and Titan II second stage booster.

MARCH 16

The Unified S-Band station at Bermuda was accepted from Collins Radio Corp.

MARCH 17

40TH ANNIVERSARY OF GODDARD ROCKET FLIGHT MARKED BY SPACE ACTIVITY

The nation marked the 40th anniversary of Robert Goddard's pioneering rocket flight with a three-ring celebration. President Lyndon B. Johnson promised the U.S. would be first on the moon as he received the National Space Club's Goddard Trophy and Vice President Humphrey looked toward more ambitious future programs as he made his second annual Goddard address. Side arenas at Cape Kennedy and Jackass Flats, Nev., featured a Gemini/Agena shot and a successful nuclear reactor test. Even the Russians got into the act by bringing back their space dogs.

"We intend to land the first man on the surface of the moon and we intend to do it in the decade of the sixties," the President declared at a small awards ceremony. Regarding competition in space, although he did not mention the Soviets specifically, he said, "We have caught up and we are going to pull ahead." He added, "I want to declare once again that so long as I am in public office this country will never again fall behind." Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, said afterward that he believed this was the first time that the President had publicly said flatly that the United States would beat the Soviets to landing a man on the moon.

Humphrey defended the FY '67 space budget as one that would permit some accomplishments despite such drains as Viet Nam although some objectives had to be postponed. Humphrey's six points were:

1. Exploration of the lunar surface and possibly the establishment of one or more permanent bases there.

2. Development of a whole family of earth orbiting stations, manned and supplied by regular ferry services.

3. Building of spaceports in a number of places in this country for the departure and arrival of spacecraft.

4. Development of recoverable and reusable launch vehicles and maneuverable space stations, with a consequent drastic reduction in the cost of space travel.

5. Improvement of propulsion methods, with the use of nuclear as well as chemical energy, so that faster and more powerful rockets can make planetary trips in a week or less which today would require many months.

6. Launching of unmanned probes to every part of the solar system—and perhaps manned planetary expeditions as well.

The Gemini flight was a worthy introduction to the day with on-time liftoffs of the Agena at 10 a.m. (EST) and the Gemini at 11:41 a.m. The Nerva Reactor Experimental Engine System Test (NRX-EST) provided 13 minutes at full power, the longest to date. Total firing time at the joint NASA-AEC Nuclear Rocket Development Station was 18 minutes.

The two Soviet space dogs were in good condition when brought down yesterday after 23 days in orbit, according to the news agency Tass. "Preliminary data were obtained on the effects of long space flight on living organisms at a considerable distance from the earth," according to the official announcement.

MARCH 17

The GSFC Data Operations Branch skin tracked the TITAN II second stage booster of the GTA-8 mission. It reentered in the Pacific Ocean approximately 2228Z on March 17, 1966. The branch also has been tracking the Agena vehicle. The beacons were live, and the Agena was stored in a 220 n.m. circular orbit. Real time tracking support was terminated at 2030Z, March 19, 1966.

Technician's unpack the OAO-A1 after its arrival at Cape Kennedy.

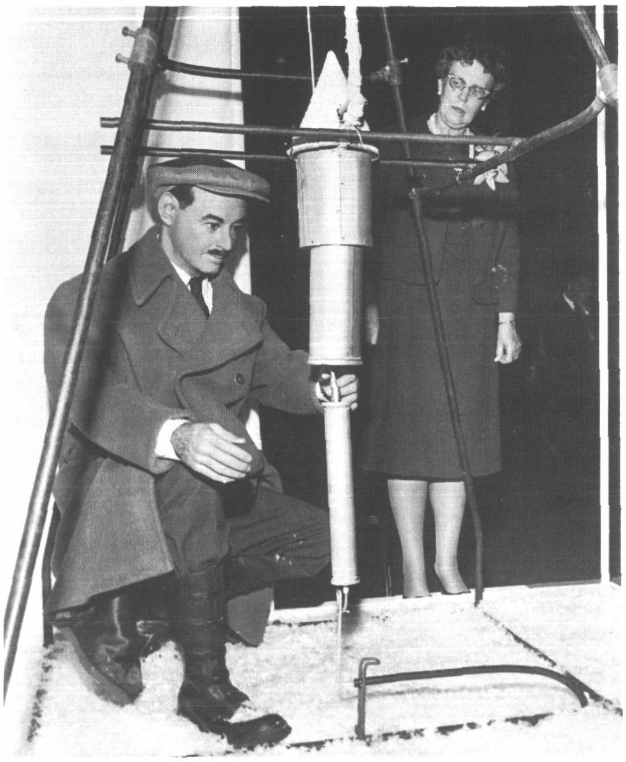
MARCH 29

Acceptance tests for Unified S-Band facilities at Carnarvon, Australia were completed.

LATE MARCH

The OAO-A 1 launch was aborted on 28 March when upper altitude winds were unfavorable and the Agena telemetry malfunctioned. The launch was again aborted on 30 March when an incorrectly installed check valve in the Atlas sustainer system caused the Atlas to shut down immediately after booster engine ignition. Launch was later being planned for April 4, 1966.

During both countdowns the Spacecraft and the experiments functioned well.



Mrs. Robert H. Goddard, widow of the American space pioneer, officiates at the opening of a Goddard tableau at the National Wax Museum, Washington, D. C.

EARLY APRIL

Building construction of the NASCOM Madrid communications center was on schedule. Arrangements have been made for the Spanish National Telephone Company (CTNE) to have access to the communications rooms in the building on June 1, 1966, to commence installation work. Installation of NASA communications equipment for this facility is scheduled for July 15, 1966.

EARLY APRIL

The first of the series of separation tests involving the Applications Technology Satellite was conducted.

EARLY APRIL

The Goddard Institute for Space Studies was moved from 475 Riverside Drive to 2880 Broadway, New York City.

APRIL 1

All equipment associated with the Guam interium voice/data facility control system was shipped from Goddard. Installation was scheduled for June 1. The entire Guam Switching Center was scheduled to be operational October 1, 1966.

APRIL 4

Nineteen new pilots were to join the United States astronaut team early in May, including one physicist from the staff of the Goddard Space Flight Center.

They boosted the total number of NASA astronauts to 50.

The Goddard scientist was Dr. Don L. Lind, 35, physicist. Since 1964, he has been working on experiments to determine the nature and properties of low energy charged particles within planetary magnetospheres and in interplanetary space.

Four civilians were among those selected. Of the remainder, seven were Air Force officers, six Navy officers, and two Marine Corps officers.

Recruiting of the new astronauts began September 10, 1965. A total of 351 submitted applications, of which 159 met basic requirements. Of that number, 100 were military, 59 civilian.

Average age of the group was 32.8 years. Average number of college years was 5.8, and average flight time was 2,714 hours, of which 1,925 hours was jet time. Two of the new astronauts had doctorates. Two are single.

Comparison among astronaut groups at time of selection:

	1959	*1962*	*1963*	*1965*	*1966*
Age	34.5	32.5	30.0	31.2	32.8
College yrs.	4.3	4.6	5.6	8.0	5.8
Flight hrs.	3,500	2,800	2,315	–	2,714

APRIL 4

Spain's Instituto Nacional de Tecnica Aeroespacial (INTA), was to share in the operation of the U.S. space tracking station near Madrid. The station maintains radio contact with unmanned probes to the Moon, Mars, and Venus and was to support Apollo astronauts on their flight to the Moon.

Under a contract, Spanish engineers and technicians were to receive training and be assigned positions in the operation and maintenance of the NASA station located near Robledo de Chavela, 40 miles west of the Spanish capital.

APRIL 4

The establishment of the John C. Lindsay Memorial Award commemorating the launching of the first Orbiting Solar Observatory on March 7, 1962, was announced. It will be given annually to a Goddard employee for the "most outstanding contribution to space science or technology." The award consists of a certificate and plaque. All employees were elegible for the Lindsay Award regardless of their occupation or

organization within which they serve. There was no limit to the number of recommendations that may be submitted. The award was based solely on the merit of the personal contribution to space science or technology.

Selection will be made by an award committee established by the Director for this purpose. The contribution may be a professional paper, a research project, or other achievement during the year preceding the date of the announcement.

APRIL 6

Incentives paid to Hughes' Aircraft, by the Communications Satellite Corporation reached a total near 1.5 million on the first anniversary of the launching of the Early Bird Satellite (Intelsat I).

APRIL 8

The OAO-1 was launched into a circular orbit, apogee 439.2 n.m. and perigee 428.6 n.m., period 94.3 minutes, 35° inclination. Preliminary analysis of data indicated that problems developed soon after insertion which caused excessive battery temperatures, loss of telemetry channels, and frequent resetting of the clock. Ultimately electric power was depleted and the spacecraft went silent except for an occasional signal from the beacon and/or the narrow band transmitter. During the early orbits the spacecraft, in spite of its difficulties, acquired the sun, achieved coarse pointing and appeared very stable.

APRIL 10

AE-B was shipped to Cape Kennedy having completed satisfactorily all pre-shipping preparations.

APRIL 10

The USNS Kingsport, first ocean link in America's research in communications by satellite and the ship which relayed western Pacific voice contact with Gemini 8, has finished her job and was to be retired from NASA's networks.

It was Kingsport which relayed voice reports from Astronauts Armstrong and Scott that the Gemini 8 spacecraft had undocked from the Agena.

From Gemini high over the Pacific Ocean, the astronaut's voice and spacecraft telemetry beamed to the instrumentation ship Coastal Sentry north of the Philippines. The Coastal Sentry sent the transmission to the Kingsport stationed nearby.

The Kingsport beamed the signal on Syncom III orbiting 22,300 miles overhead. The satellite instantaneously relayed the transmission down to Hawaii from which cable and land line circuits continued to NASCOM communications center at the Goddard Space Flight Center, Greenbelt, Md., and then to Mission Control at Houston.

The Kingsport gave the world's first demonstration of communications by a satellite in synchronous orbit. This was in July, 1963, through Syncom II over a 45,000-mile loop from the ship to Syncom and back to Kingsport at anchor in Lagos Harbor, Nigeria.

She was part of the first direct exchange of radio messages via satellite between North America and Africa a few days later, linking the terminal station at Lakehurst, N.J., with land circuits at Lagos, Nigeria.

On August 4, 1963, Kingsport and Lakehurst transmitted and received via Syncom II the first satellite exchange of news copy and photo facsimile. Photos were exchanged of the late President Kennedy and Nigerian Governor-General Azikewi.

Kingsport then put to sea. Forty miles off shore, although caught in a squall and rolling and pitching in high wind and water, she became the first terminal station to establish satellite communications from the open sea.

Two months later, again with Syncom II, Kingsport made possible the first trans-ocean press conference by satellite. Stationed at Rota, Spain, she connected Syncom communications between United Nations in New York and NASA Headquarters in Washington, with the International Telecommunications Union Conference at Geneva, Switzerland. Ambassadors in New York and Washington joined NASA engineers to talk to the national delegations at Geneva. Journalists on both sides of the Atlantic held radio interviews on decisions being made at Geneva on allocation of radio frequencies which would affect the future of space communications.

She was built in Los Angeles in 1944, at the California Shipbuilding Corp., destined for Army Transport Service. With 11,000 tons displacement, she was an oceangoing craft of 455 feet overall and 62-foot beam. She was graceful, fast and sturdy, a Victory ship (VC-2), tagged T-AG-164, impressive on the sea as a Percheron on the farm, a work horse for transport of material or men.

In her sixth year, on March 1, 1950, the Navy renamed her the USNS Kingsport and transferred her to the Military Sea Transportation Service where as a cargo ship she sailed on a world-wide schedule.

Eleven years later (she was now 16), she was chosen by the Bureau of Ships to be the Navy's first communications satellite ship.

APRIL 14

Spanish Foreign Minister Fernando Castiella and United States Secretary of State Dean Rusk confirmed two agreements involving cooperation between Spain and the United States in space.

The first agreement provided for continued use by NASA of its manned space flight station on Grand Canary Island, while the second agreement provided for a cooperative Spain-United States scientific sounding rocket program to measure winds and temperatures at high altitudes.

The Canary Islands agreement outlined expansion of facilities at the station to support the Apollo lunar landing project and other space exploration programs. The original agreement of March 1960 established the station for one-man Mercury missions and it has continued in service for the two-man Gemini flights.

The new agreement for the three-man Apollo missions and more advanced programs runs until January 29, 1974.

MID APRIL

Work continued to prepare detail plans preparing for transfer of TIROS operational functions to The Environmental Science Services Administration.

APRIL 18

Representatives of the Internationella Meteorologiska Institut i Stockholm visited the GSFC Optical Systems Branch to coordinate plans for the forthcoming studies of noctiluminescent clouds over Sweden during the summer of 1966.

APRIL 20

NESC assumed all archival film functions for data obtained from the Operational Weather Satellite Program, April 20, 1966. Backlog of archiving was to be accomplished under present procedures and is expected to be completed by June 1966.

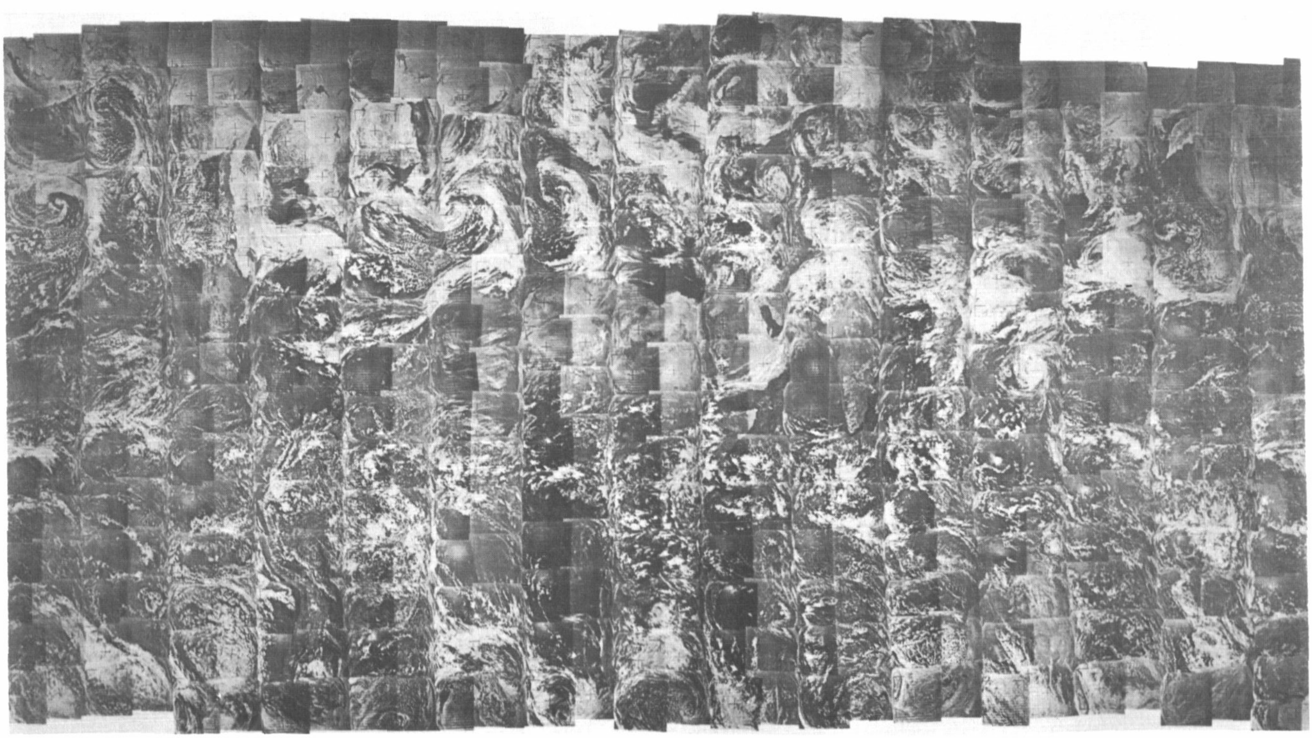
APRIL 21

Analysis of the OAO A-1 Spacecraft performance and problems continued. During the first few minutes of orbital operation after separation the Spacecraft was apparently performing well. A large electrical transient occurred over Orroral as spacecraft status data was being taken. The following stabilization and control modes were demonstrated satisfactorily at least once each:

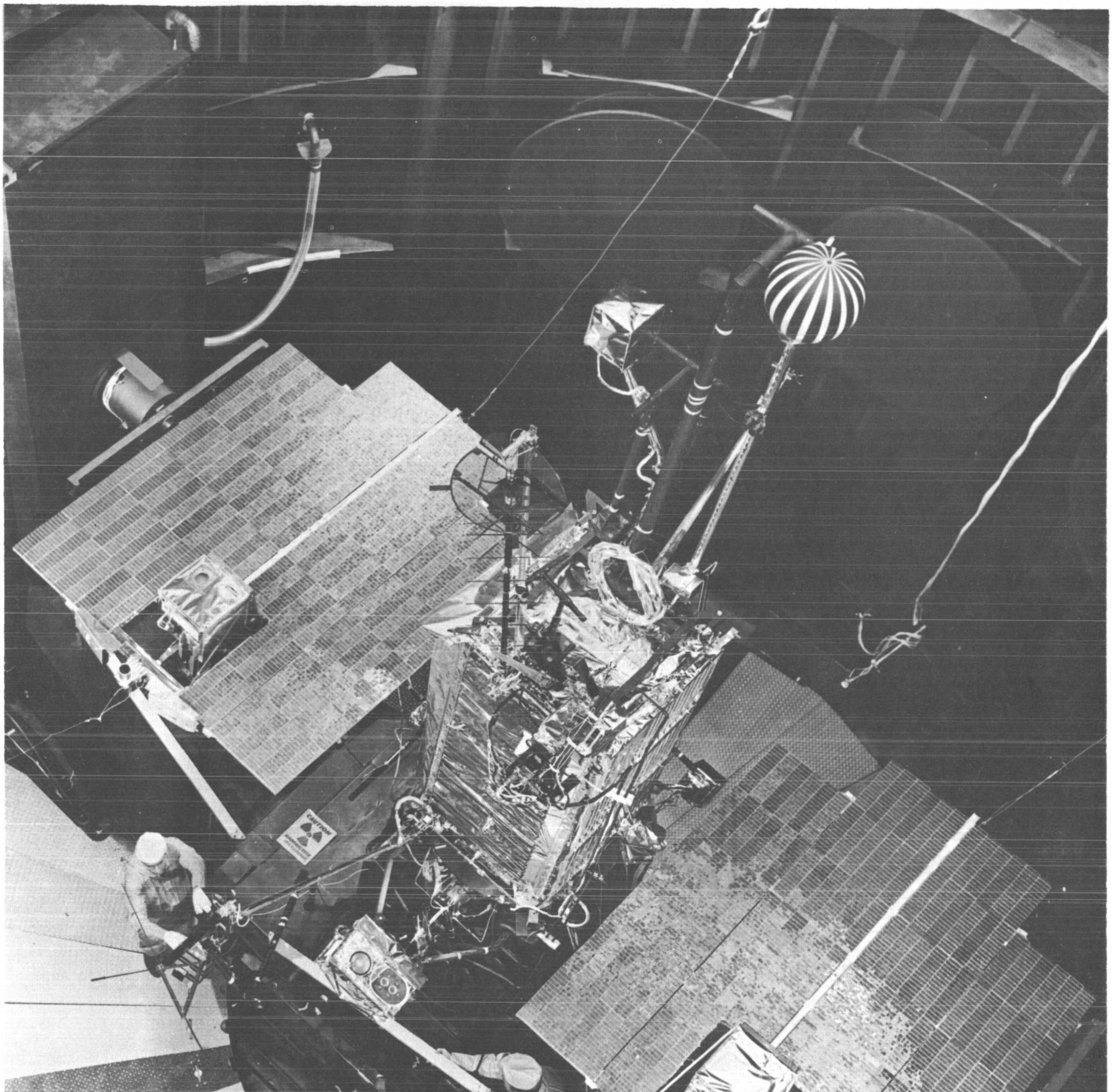
a. Rate stabilization during darkness
b. Coarse sun pointing
c. Fine sun pointing
d. Roll search
e. Coarse pointing
f. Jet unloading

APRIL 25

A five-man board was established to conduct a broad review of the Agency's observatory-class earth satellites.



The world's weather as seen by ESSA 1, April 12, 1966.



The 1,135-pound Orbiting Geophysical Observatory-B, third in the National Aeronautics and Space Administration's geophysical spacecraft series, undergoes an environmental test in a space simulator at the Goddard Space Flight Center.

The board was to study all phases of design, development, testing and space operations procedures of the orbiting observatory spacecraft.

Robert F. Garbarini, Deputy Associate Administrator for Space Science and Applications (Engineering) was named chairman of the board.

The review was to include procedures and methods used to provide for effective contractor project management, design, design review and approval procedures, parts and component selection, quality control, testing procedures, and the planning and conduct of the operation of the spacecraft, including training and rehearsal procedures used prior to launch.

APRIL 29

Goddard's NASCOM Division participated in the SA-5 re-entry.

APRIL 29

Mrs. Melba L. Roy, formerly Head of the Program Production Section, Advanced Orbital Programming Branch, was named as Head, Advanced Orbital Programming Branch, Data Systems Division, Tracking & Data Systems Directorate. Mrs. Roy will also serve as Acting Head of the Program Production Section and of the Operator Design & Development Section. This appointment filled the vacancy created by the reassignment of Mr. Thomas P. Gorman to the position of Head, Telemetry Computation Branch, Information Processing Division.

Also Mr. Thomas P. Sciacca, Jr., was named Head, Electronic Materials Section, Materials Research & Development Branch, Systems Division, Technology Directorate, replacing Dr. Henry E. Frankel who has been acting Head of this Section. Dr. Frankel continued as Head of the Materials Research & Development Branch.

EARLY MAY

The configuration of the towers for the microwave links, at Madrid, Canberra and Goldstone were finalized.

EARLY MAY

An agreement has been reached with JPL on the transfer of design responsibility to GSFC for the JPL supplied equipment used in the Unified S-Band System.

EARLY MAY

ESSA-1 completed 3 months of regularly providing good quality data from both camera systems. TIROS X was being used to supplement ESSA-1 data.

MAY 2

All orders have been placed for circuits required for GTA-9. The NASCOM Network was configured for GTA-9.

MAY 3

After a long period of poor weather, two successive passes of Beacon-Explorer-C were laser tracked. Laser range measurements were obtained at 381 points during the first pass and 253 points during the second. Many of the measurements were made while the satellite was in the earth's shadow, and therefore not visible, the transmitter and receiver being directed by digital programmer.

MAY 4
The IMP III spacecraft became silent at 6:57 AM EDT and was turned back on by the three-hour timer at 9:54 AM EDT.

MAY 4
Personnel from Cable and Wireless, Ltd. began the installation of the Bermuda High Frequency Radio High Speed Data Terminal for Apollo High Speed Data System at Bermuda. When operational, this system will provide Category III testing for the Apollo Ships through Bermuda to Goddard.

MAY 4
The Argentine Space Commission (CNIE) successfully launched the first in a series of meteorological rockets from its launch range at Chamical. The launching was conducted by Argentine scientists and technicians under a cooperative program with the NASA.

MAY 5
Dr. John F. Clark, was named Director of the Goddard Space Flight Center it was announced by Administrator James E. Webb.

Dr. Clark had been acting director of Goddard since July 1965.

To succeed Clark at his previous Headquarters position, Dr. John E. Naugle was named Deputy Associate Administrator for Space Science and Applications (Science).

Prior to coming to NASA in 1958, Dr. Clark was head of the Atmospheric Electricity Branch of the Naval Research Laboratory where he managed a number of rocket programs to study various atmospheric phenomena. At NASA, he served in the Office of Space Sciences where he was appointed Director of Physics and Astronomy Programs in 1961 and as Director of Sciences for OSSA in 1963.

MAY 8
A high altitude balloon was conducted in cooperation with the University of Michigan. Two spectrometers (IRIS and 7-15 micron Filter Wedge) plus supporting radiometers and cameras were on board. The balloon stayed at 10,900 ft. for more than 6 hours. Preliminary data looked good. Final data reduction expected to be completed by September.

MAY 9
A Convair 990 jet aircraft was to be used to take cloud-cover pictures and infrared measurements over selected areas of the United States and the Caribbean Sea as part of NASA's weather satellite sensor development program.

Jet flights were to support NASA's Nimbus C weather satellite in its data-gathering over North and South America. Nimbus scheduled to be launched during mid May from the Western Test Range, Cal.

A high-altitude observatory airplane was to be used to test new weather-measuring sensors for use in satellites and comparing data collected by the aircraft and spacecraft over the same areas. After Nimbus was to be launched, the NASA jet will fly over coordinated areas so that pictures and other data can be obtained from the aircraft and spacecraft simultaneously.

MAY 10
Explorer XXXI (DME-A) problems have developed, the project staff was unsuccessful in command attempts between 7 May and 10 May. Quick look information suggested that the 2 and 5 watt bleeds employed for thermal energy dumping were "on" causing a high drain on the battery. Permanent damage had not yet been assessed. APL was investigating the possibility of a battery restoration phase.

MAY 12
A cooperative agreement to investigate the physics of comets, the interplanetary medium and earth's magnetosphere was concluded by the Ministry for Scientific Research (BMwF) of the Federal Republic of Germany and the National Aeronautics and Space Administration.

Two sounding rockets, expected to be launched in the fall of 1966, will release vaporized metal in the upper atmosphere to create artificial ion clouds which will be observed from the ground by means of special optical equipment.

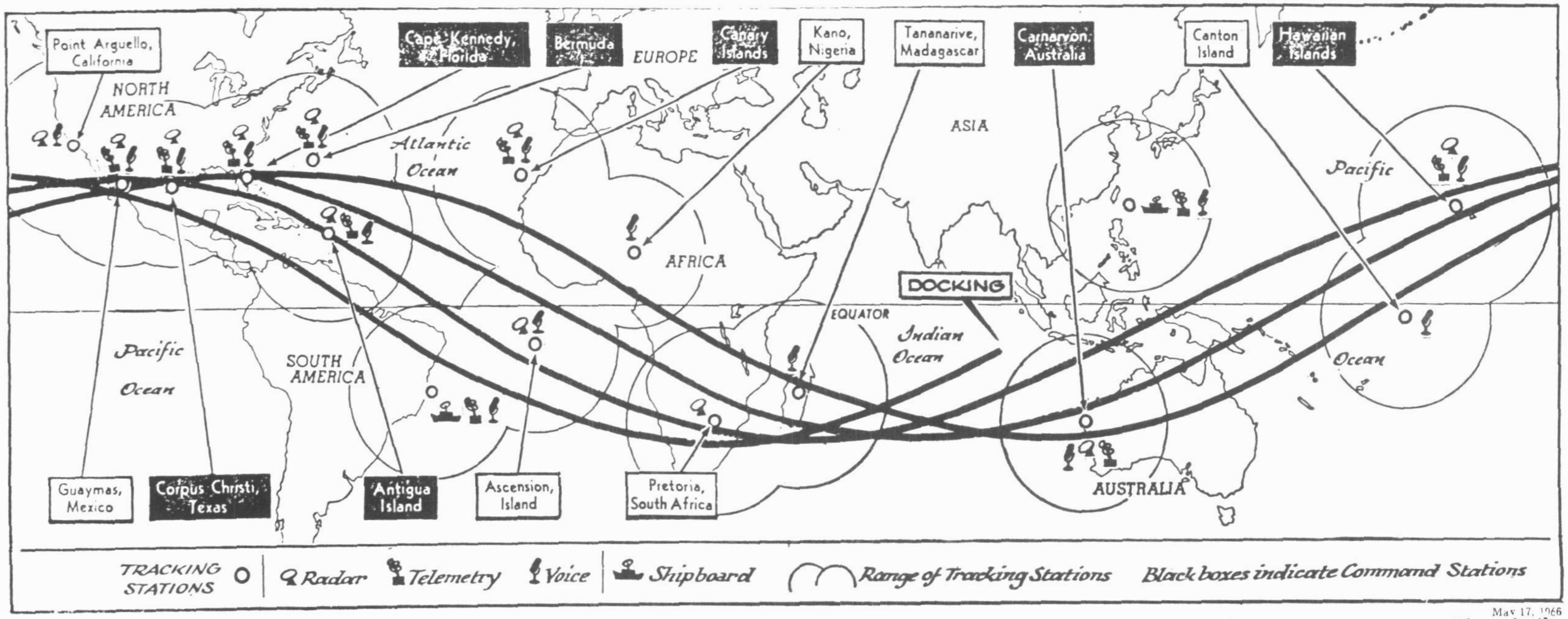
Results of the project will be reviewed to determine the desirability of conducting similar experiments on a larger vehicle at a distance of several Earth radii.

Under the agreement, BMwF will provide the rocket payloads, supplementary cameras and photometric equipment. NASA will furnish one Javelin and one Nike-Tomahawk rocket together with the launching range and support facilities and equipment for optical observations. Each organization will assume the costs of its agreed responsibilities.

MAY 13
A damaged spacecraft antenna has slipped the AE-B launch at least 2 days to May 13, 1966 (1630 to 1730Z). The antenna was damaged on-stand during F-0 day operations. The spacecraft was then de-mated and taken back to the hangar for repair and checkout. The impact of the Nimbus launch, and its conflicting tracking and data requirements had not been resolved.

MAY 15
Nimbus II lift-off occurred 0755 GMT from WTR/VAFB. Near perfect launch vehicle performance resulted in an injection into an orbit of 593 NM perigee and of 639 NM apogee with an inclination of 100.3 deg. and orbital period of 108 minutes.

THE NEW YORK TIMES, TUESDAY, MAY 17, 1966.



May 17, 1966

Flight of Gemini 9 is followed on worldwide network of stations shown on map. **Black boxes indicate primary shore stations. In addition, two ships—the Rose Knot Victor in the Atlantic and the Coastal Sentry in the Pacific—also carry primary stations. These primary stations can issue commands by radio to guide the spacecraft from the ground; other stations are limited to communication and tracking. Path of Gemini 9 is shown from launching to point over the Indian Ocean where it is expected to dock with an Agena rocket.**

Worldwide Tracking Network for Gemini Astronauts Starts Its Work Early

By JOHN NOBLE WILFORD

Special to The New York Times

HOUSTON, May 16—A 39-year-old engineer will sit down at his console at the Mission Control Center here and flip a switch at 2 A.M. tomorrow.

The engineer, Anthony Genovese, is one of the first men expected to report for duty on launching day for Gemini 9. His job is to place the telephone call that activates the globe-circling network of computers, radar and communications link that tracks every manned space flight from liftoff to splash-down.

His message will be cryptic: "Is Goddard cleared for testing?"

The Goddard Space Flight Center at Greenbelt, Md., is the switchboard for the tracking and communications network of 89 remote stations and half a billion miles of circuits. More than 1,000 men operate the stations and relay points in London and Africa, on lonely islands and anchored ships.

Within minutes of the initial telephone call, computers at Goddard and Houston will come to life. Electronic signals will pulse around the world by cable and landlines, radio and communications satellite.

The lines and equipment are checked by computers to see that they are ready to support a Gemini mission. A conference call to 100 points connects flight controllers with all stations.

The network serves as the orbiting astronauts' lifeline with earth. For Gemini 9 the network is especially critical because it must simultaneously track two vehicles—the Gemini and its Agena target vehicle—as well as monitor Lieut. Comdr. Eugene A. Cernan as he floats around the world outside the craft.

Through data received by remote tracking stations and relayed instantaneously to Houston, flight controllers will be able to watch Comdr. Cernan's heartbeat and respiration and keep tabs on how his equipment is working.

Verne Stetler, chief of the space agency's communications division, describes the operation as the "largest real-time network in the world."

Because scores of computers operate the complex switchboard and process the data both at the tracking sites and at the control room, it takes only 1.6 seconds for information to travel from astronaut to flight director. That is what space engineers mean by real-time.

Only once has trouble in the tracking network postponed a launching. A malfunctioning radar on Bermuda forced a two-day delay in the liftoff of Mercury 9 in May, 1963. Being the first station to track the Gemini after launching, Bermuda must confirm that the craft has achieved a proper orbit.

Never has a mission, once under way, been altered or cut short because of a network failure.

The lifeline consists of 10 Cape Kennedy, Bermuda, Antigua, Grand Canary Islands, Australia (Carnarvon), Hawaii, Mexico (Guaymas), Texas (Corpus Christi) and on two refurbished Liberty ships, the Rose Knot and the Coastal Sentry.

From 40 to 80 computer and communications specialists man each outpost. They are generally Americans on two-year tours of duty, but the Carnarvon station is all Australian. An astronaut is posted to each station to serve as communicator with the spacecraft as it passes over.

There are smaller stations in Nigeria, Madagascar, California, New Mexico and Florida.

A remote station "sees" an orbiting Gemini with an electronic antenna. Once it locks on to the Gemini's radio signals, it begins receiving a stream of data called telemetry at the rate of 51,000 bits of computer language a second.

These bits are digested and coded by data processing systems at the tracking station, then transmitted by way of Goddard to Houston where they are converted by computers to meaningful information.

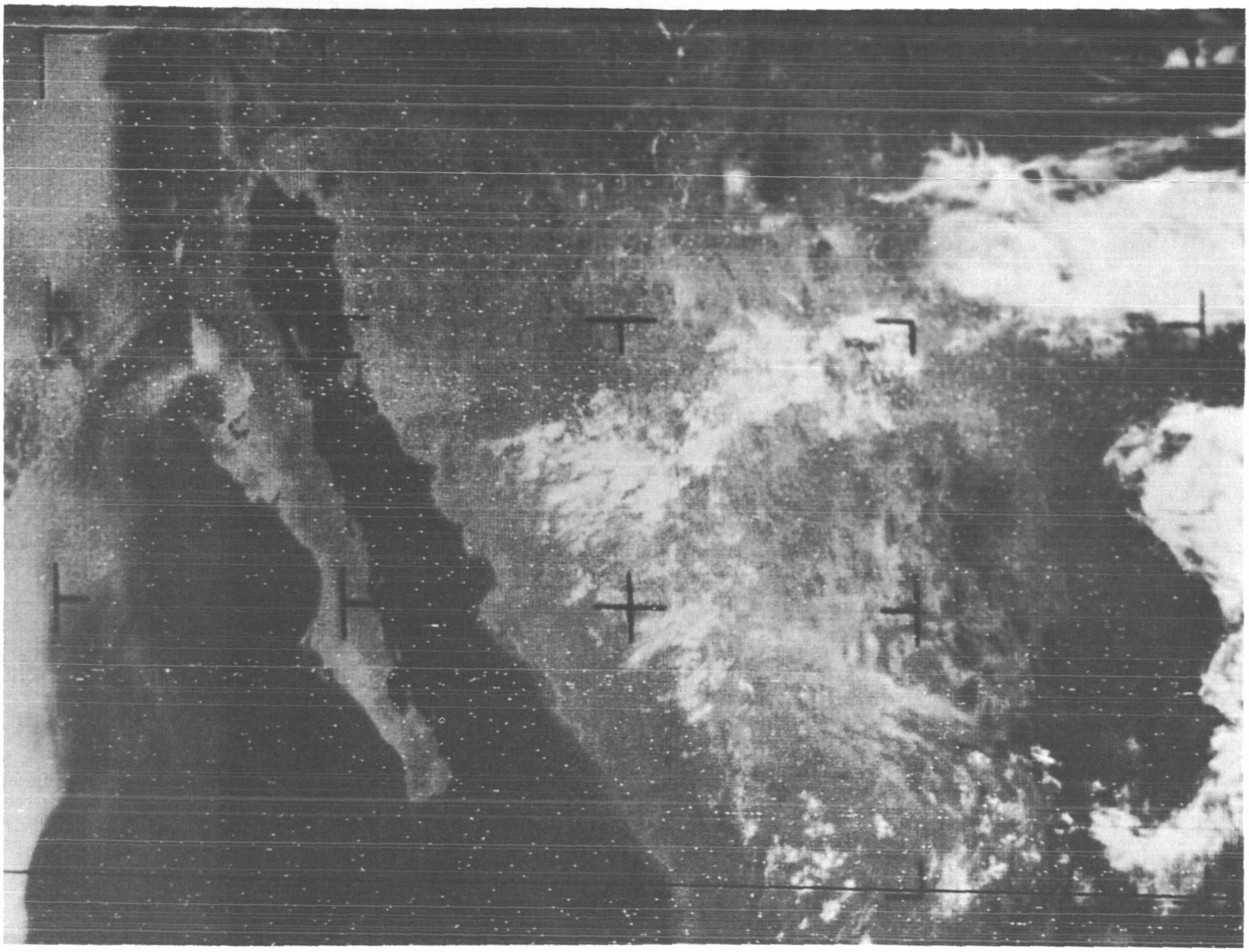
Before the Gemini is due to pass over a station, flight controllers in Houston tell the station what instructins to pass on to the astronauts and any additional data that should be fed to the Gemini onboard computer.

Still, there are times when the astronauts are on their own. They are usually in clear range of a site for only six to seven minutes. When they pass out of range, it is often several minutes, sometimes nearly an hour, before their signal is picked up by the next station.

In March, Gemini 8 was out of range, between Tananarive, Madagascar, and the Coastal Sentry, when its maneuvering thruster fired out of control and forced the abrupt end of the mission.

Some orbital paths, because of the earth's tilt, swing far to the south so that it is possible to fly nearly half way round the word before reaching the next primary station.

Missions are planned so that on such orbits the astronauts are either sleeping or inactive. During out-of-range periods, data are recorded onboard for transmission later to the next tracking station.



An APT ground station at the Goddard Space Flight Center received this "live" photo of Baja, California, at 2:15 p.m. May 18th. The picture shows Baja, including Harbor de La Paz at the southern tip, Pacific Ocean, Gulf of California and Mexico.

All experiments and spacecraft systems were performed to specifications. Tracking and data acquisition continued without incident. The spacecraft activation and operations conformed to pre-launch objectives and load profiles.

MID MAY
The Alouette I satellite operated in a 100% sun orbit for approximately three hours per day, with batteries numbers two, four, and six on standby.

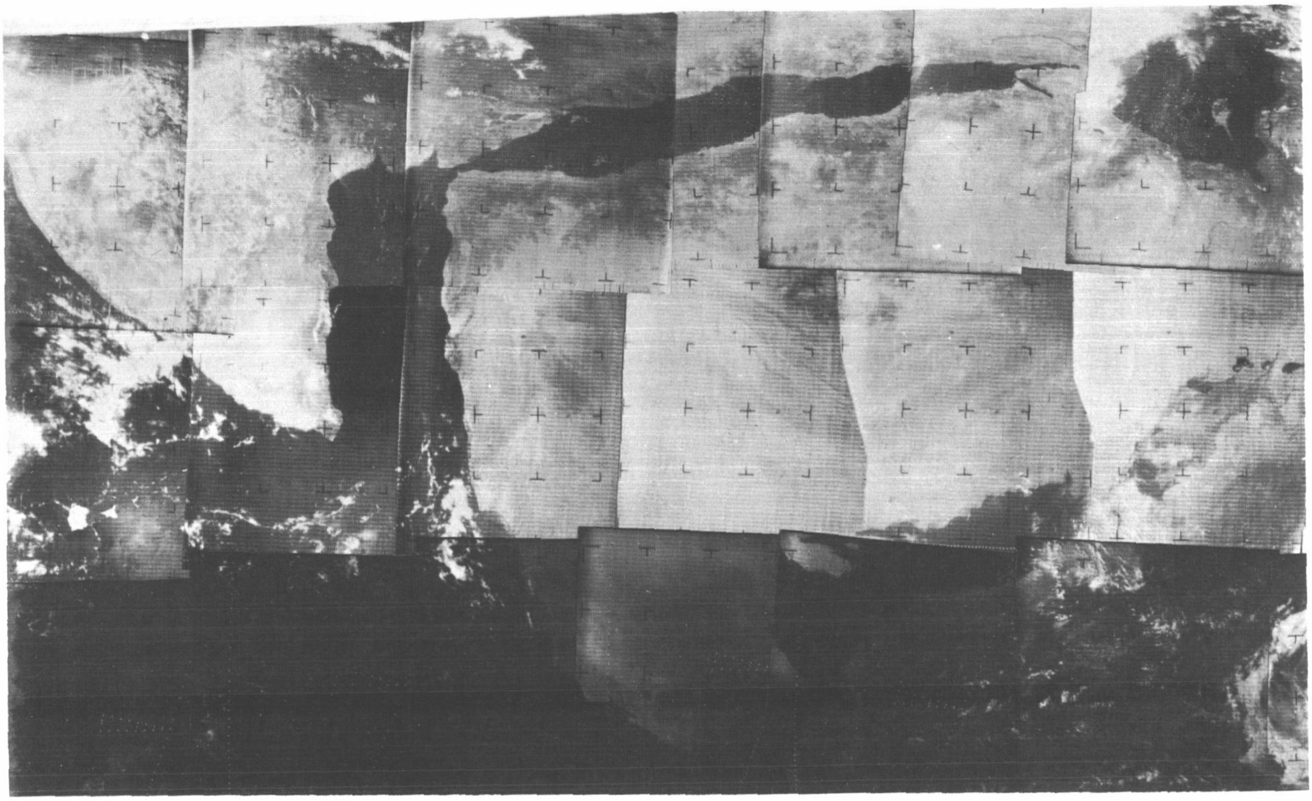
Alouette II satellite operated in a 100% sun orbit for approximately seven and one half hours per day. Minor command difficulties were being experienced.

MID MAY
All Teletype equipment for Apollo remote sites had been received, with the exception of eight Receive/Transmit Units. Equipment was shipped to Guam, Ascension, Bermuda, Guaymas, Canberra, and the Grand Bahamas van at the Collins Radio Plant, Richardson, Texas. Equipment for Madrid, Canary, and Antigua was scheduled to be shipped in time to meet existing implementation schedules.

MID MAY
Installation of the new communications facilities between Lima, Peru, and New York was complete. Preliminary test results indicated that voice and Teletype facilities to Lima were of excellent quality.

MID MAY
The relocation of TIROS equipment from the Wallops Station site to the TOS/ESSA site began Mid May and was expected to be complete and operative by May 20, 1966.

MAY 16
It was announced that Lockheed Missiles and Space Co., Sunnyvale, Calif., and the Radio Corporation of



From 700 miles above the Nile Delta, the high resolution cameras in the Nimbus II weather satellite snapped this panoramic view at about noon May 17. Seen in the montage of 18 pictures some 700 miles below the satellite (starting at the bottom of the picture) are the Indian Ocean, Somalia, Ethiopia, Gulf of Aden, Saudia Arabia, Persian Gulf, Sudan, United Arab Republic, Red Sea, Gulfs of Suez and Aqaba, the Nile River, Jordan, Dead Sea, Israel, Mediterranean Sea and Cyprus.

America, Princeton, N.J., were to study characteristics for a proposed Orbiting Data Relay System (ODRS).

Each study contract was to be for approximately $90,000, for a six month period. From a field of eight bidders, the two firms were selected in order to obtain two professional points of view from studies independent of each other.

The studies will probe the kind of synchronous satellite and ground facilities required to relay data from spacecraft in Earth orbit to NASA's mission control centers at Goddard Space Flight Center, Greenbelt, Md.; Space Flight Operations Facility, Jet Propulsion Laboratory, Pasadena; and the Manned Spacecraft Center, Houston.

MAY 16

It was announced that two pioneer tracking and telemetry stations were to be closed in the near future because of technical progress in space communications: East Grand Forks, Minn. was to cease operation June 30, while the Blossom Point, Md. station was to close Sept. 30, 1966.

Both stations were in use in the early days of space exploration. The Blossom Point station was the first tracking stations established by the United States for Project Vanguard and served as a prototype for all Vanguard stations set up for the International Geophysical Year, 1957-58. It has tracked every unmanned Earth-orbiting NASA satellite launched since then.

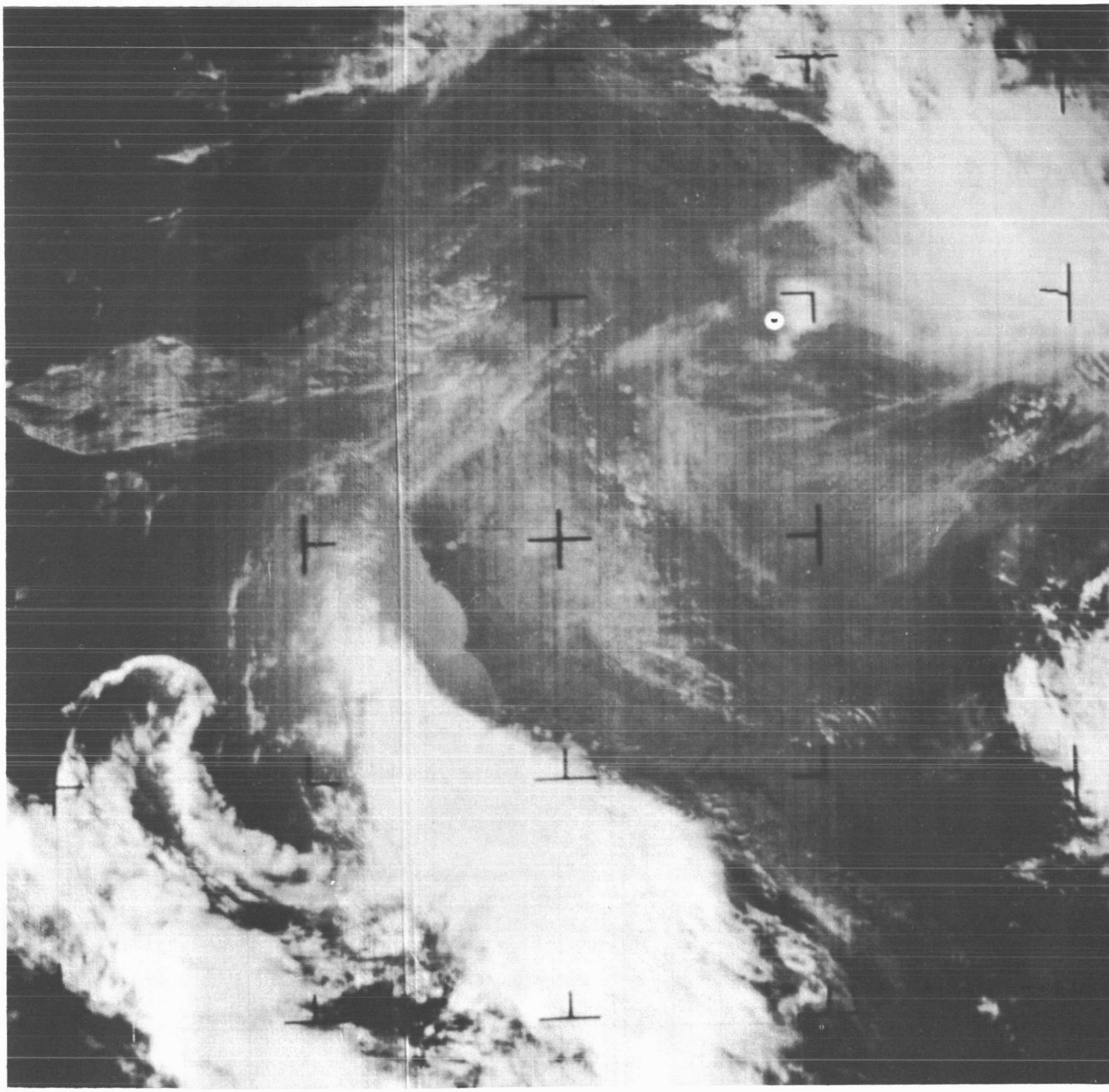
The East Grand Forks station was a veteran of almost five years of space tracking.

These stations were among several located in the western hemisphere to receive signals from spacecraft passing overhead in the near-equatorial and near-polar orbital paths of the early unmanned space flights.

Measurements were transmitted to computers located at the Goddard Space Flight Center.

MAY 18

An experiment to measure the brightness of stars was launched at Wallops Island, Va.



The Eastern Seaboard, Chesapeake Bay, Great Lakes, Gulf of Mexico and Florida Peninsula as seen by Nimbus II. This is the first picture taken by the satellite's Automatic Picture Transmission system at 12:22 p.m., May 15, about 9 hours after the spacecraft was launched. Orbiting the earth at an altitude of some 700 miles, this picture covers an area of some 1½ million square miles.

The probe of electron temperature experiment is attached to the flight model of the AE-B. The spacecraft was placed on a spin table used to rotate the spacecraft in relation to the sun as a means of checking its optical aspect system.

Monitoring the OAO – Donald Eckel, Donald Stillwell and William Olden monitoring the telemetry signal being decoded by the Data Transmission System during the OAO-A1 launch, April 8, 1966.

The 188-pound payload, flown on an Aerobee 150A sounding rocket, carried eight photoelectric photometer/telescopes to look at the stars and record ultraviolet radiation or light in four spectral bands.

The Aerobee rocket lofted the telescope and related instrumentation through a peak altitude of 131 miles, high above most of the Earth's atmosphere, to get a clear view of ultraviolet radiation which does not penetrate the atmosphere and therefore cannot be observed from the ground.

Lift-off occurred at 12:02 a.m. EDT-

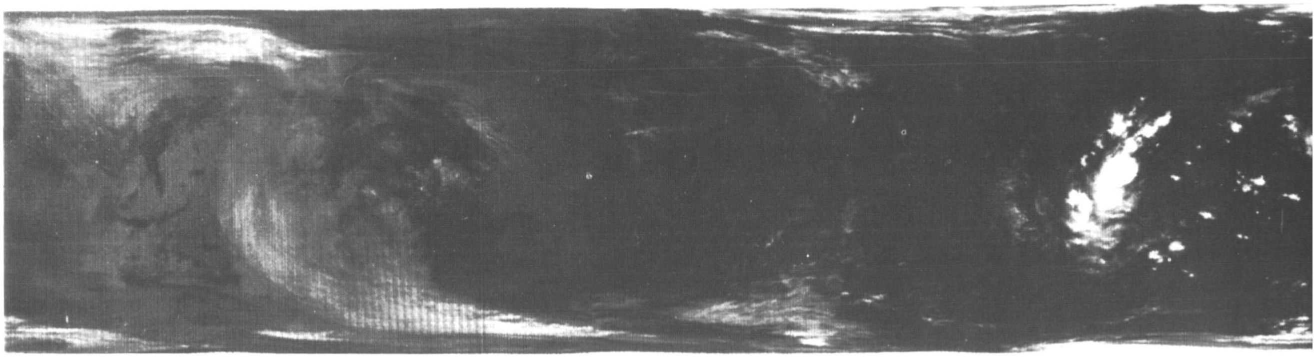
MAY 10

GSFC participated in the GT-9 Simulated Launch Demonstration. Communications were good with one exception. Nineteen minutes prior to simulated lift-off all Goddard-Houston Teletype circuits were reported out of service. However, sixteen minutes later, six circuits were restored and traffic resumed. Three minutes later the remaining channels were restored for service.

MAY 17

The Atlas-Agena target vehicle for GTA-9 was launched from Complex 14, Cape Kennedy on a launch azimuth of 84.4°. Lift-off occurred at 15:15:02.8Z. The launch appeared normal until approximately 128 seconds after lift-off when the Atlas malfunctioned. One of the engines did a "hardover" and the other engines could not compensate. The Atlas main engine continued to burn but the trajectory was erratic. It climbed to a maximum altitude of about 43 NM and then splashed at about 15:22 GMT. The GSFC computed splash point was:

$\phi = 28.8^\circ$ N Latitude
$\lambda = 75.2^\circ$ W Longitude



A slice of the globe from pole to pole. Less than 6 hours after launch on May 15, 1966, Nimbus II, took this remarkable nighttime photo showing a strip 1800 miles wide and 10,000 miles long extending from the ice cap surrounding the South Pole (right) to the Kamchatka Peninsula (left). Distinguishing land masses in-

GT-9 was rescheduled for 31 May 1966, using the Augmented Target Docking Adapter (ATDA) for a docking target in place of the Agena. During this mission the Atlas will also go into orbit since the ATDA does not have propulsion capability.

MAY 22

Experiment operations on OGO-I were reduced. At that time, the solar array was to be slewed to 180 degrees in preparation for a two month low power period.

The OGO-II solar array was moved from 180 degrees to 158 degrees during Revolution 3052 to take advantage of an improving power period.

Operation of OGO-II from 16 May through 22 May 1966:

Commands	207
PCM Real-Time Telemetry	43
PCM Playback Telemetry	0
Special Purpose Telemetry	0
Range and Range Rate (R & RR)	0

MAY 20

Studies of the solar eclipse were carried out in Greece under a cooperative project of the Greek National Committee for Space Research and NASA's Goddard Space Flight Center.

During the eclipse, experiments were flown on seven instrumented boosted-Arcas rockets launched from the United States Naval Ship Range Recoverer, stationed several miles off-shore from Koroni in the southern Peloponnesos. Objective of the experiments was to investigate ionization below 56 miles because of changes in the solar ultraviolet and X-ray flux caused by passage of the Moon between the Earth and Sun.

A 200-foot antenna and a van containing instrumentation was located on the shore near the town of Koroni, to record signals from the rockets.

The Ionospheric Institute of the University of Athens coordinated the Greek portion of the project. The NASA portion was under the direction of Goddard.

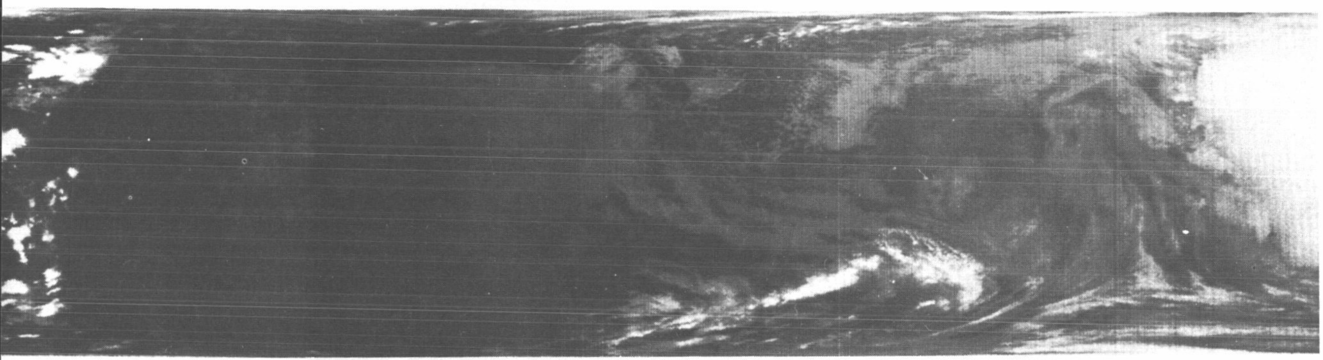
MAY 24

The biggest rocket ever fired outside the United States or the Soviet Union was launched and fell 270 miles away (a little more than half-way to its intended destination).

The Europa I rocket originally scheduled to be launched May 23, 1966, but delayed because of minor difficulties carried the hopes of six European nations and Australia to develop a joint space probe.

Officials said the motor of the rocket cut out two minutes and 10 seconds after launch. Though they admitted that the flight was not 100 percent successful they declared "its objects were achieved."

The rocket launched by the European Launcher Development Organization, crashed down in the Simpson Desert, 270 miles from the launch site. Its intended crashdown point was 460 miles from the site.



clude Tasmania, the East Coast of Australia and New Guinea. The picture shows cloud patterns over the Pacific Ocean and Bering Sea. The photo was read out on the satellite's third orbit, using its infrared camera system while the spacecraft was over the night side of the earth.

Diplomatic officials from Australia, Britain, France, Holland, Italy, West Germany, and Belgium were on hand to watch the firing.

MAY 25

AE-B was launched at 10:00 A.M. from ETR. Because of an apparent guidance system failure, WECO second stage cutoff was not achieved. As a result the apogee altitude was higher than planned. All other vehicle performance appears to have been nominal. Basic orbital elements were:

Apogee (n.mi.)	1471
Perigee (n.mi.)	150
Inclination (deg.)	64.67
Period (min.)	116

MAY 27

Under a US/French agreement a new method for improved long-range weather forecasting was to be investigated.

The project, designated Eole (the French word for Aeolus, god of the winds in Greek mythology), was to attempt collecting meteorological data on a global scale using balloons and an Earth-orbiting satellite.

The purpose of the Eole experiment is to obtain data on the circulation of the atmosphere at one or more levels over a large oceanic area. A network of instrumented constant level balloons drifting with the wind will act as tracers of air masses.

Pressure and temperature data telemetered from the balloons, as well as their location, will be recorded in the satellite memory for later transmission to ground stations.

Agreement of the Eole project was contained in a Memorandum of Understanding concluded between the Centre National d'Etudes Spatiales (CNES, National Center for Space Studies) and NASA.

The agreement provided that CNES would be responsible for the development and launching of the balloons and their payloads and for the design, fabrication and testing of the proposed satellite. NASA was to provide a Scout rocket, perform the launching, and train French personnel, as required.

MAY 27

Explorer XXXII, was operating normally. Although the satellite was in a higher apogee than intended, adjustment of onboard programming of the spacecraft's sensors was expected to compensate for the higher altitude thus some useful scientific measurements will be taken that were not planned originally.

All eight experiments on board were functioning as expected and the aeronomy spacecraft is spin-stabilized at the required 30 revolutions per minute.

Explorer XXXII is designed to collect accurate data on the upper atmosphere to provide a better understanding of how and why changes occur there. In addition, it is

studying the effects of short term disturbances in the atmosphere caused by radiation from solar storms.

Launched May 25 from Cape Kennedy, Fla., the spacecraft was placed into an orbit ranging from 1629 to 173 miles rather than the expected 750 by 170 miles. A lack of command cutoff in the second stage of the Delta launch vehicle caused it to burn an extra eight seconds which resulted in the higher apogee.

MAY 30

The GSFC Data Operations Branch provided computer support for the Surveyor AC-10 mission. Liftoff occurred at 14:41:01Z. The launch was nominal and the Centaur burn was nominal. On the basis of ASC and PRE "C" band track we computed an orbit with the following characteristics:

h_a = 238,448 n.m. apogee
h_p = 91.48 n.m. perigee
P = 17,970 min. period
i = 30.06 degree inclination
e = .9711 eccentricity

MAY 31

The TOS/ESSA facility at Wallops Island, Virginia was checked out and assumed the command and data acquisition functions of the Wallops site.

The ESSA control center facility has been modified to operate TIROS IX and ESSA-1. The equipment is being checked out with June 15, 1966 as an expected data of transfer of responsibility.

LATE MAY

Performance after the first 100 orbits of Nimbus II were as follows:

AVCS: Very good picture quality, cloud cover superior to Nimbus I. Higher orbit altitude results in no gaps. Iris #2 motor for camera I failed; the redundant motor was operating well.

APT: Picture quality good; data code grid experiment functioning well.

MRIR and HRIR: Data was excellent.

LATE MAY

Installation of Western Electric 205B High Speed Data Modems at the Bermuda T & C and USB sites was complete.

EARLY JUNE

During the GT-9 mission GSFC tracked the ATDA, the Atlas and the GLV. In addition Goddard monitored the performance of the network. During reentry GSFC confirmed the MSC time to fire and impact point. The target landing point for GT-9 was:

$\phi = 27^\circ 52'$N latitude
$\lambda = 75^\circ$W longitude

The GSFC computed impact point was:

$\phi = 27^\circ 54'$N
$\lambda = 47^\circ 58'$W

EARLY JUNE

GSFC personnel were at Santiago, Chile for acceptance testing of the Range and Range Rate system for the Anchored Interplanetary Monitoring Platform.

EARLY JUNE

The Explorer 32 satellite was fully established in orbit and operational. Simultaneous measurements of the neutral particle and ion concentration, the total density and the electron temperature and density are being made at 20 locations about the globe, on a daily basis. The unexpectedly high orbit while causing some modification of the pre-launch experiment plan, is providing a bonus in permitting first direct measurements of neutral constituents at the 2000 km level. Having operations commence at this time, where the solar activity was increasing rapidly, enhanced the usefulness of the satellite system.

EARLY JUNE

Operation of OGO-I experiments ceased until approximately mid-August 1966. The 136 MC Beacon was turned off to avoid a station look angle conflict with OGO-III.

EARLY JUNE

Dr. Norman F. Ness, GSFC, was elected a Fellow of the American Geophysical Union.

JUNE 1

ESSA-1 completed 4 months of good operation and continued to provide total earth cloud cover pictures regularly. Other active satellites were being interrogated on a minimum schedule.

JUNE 1

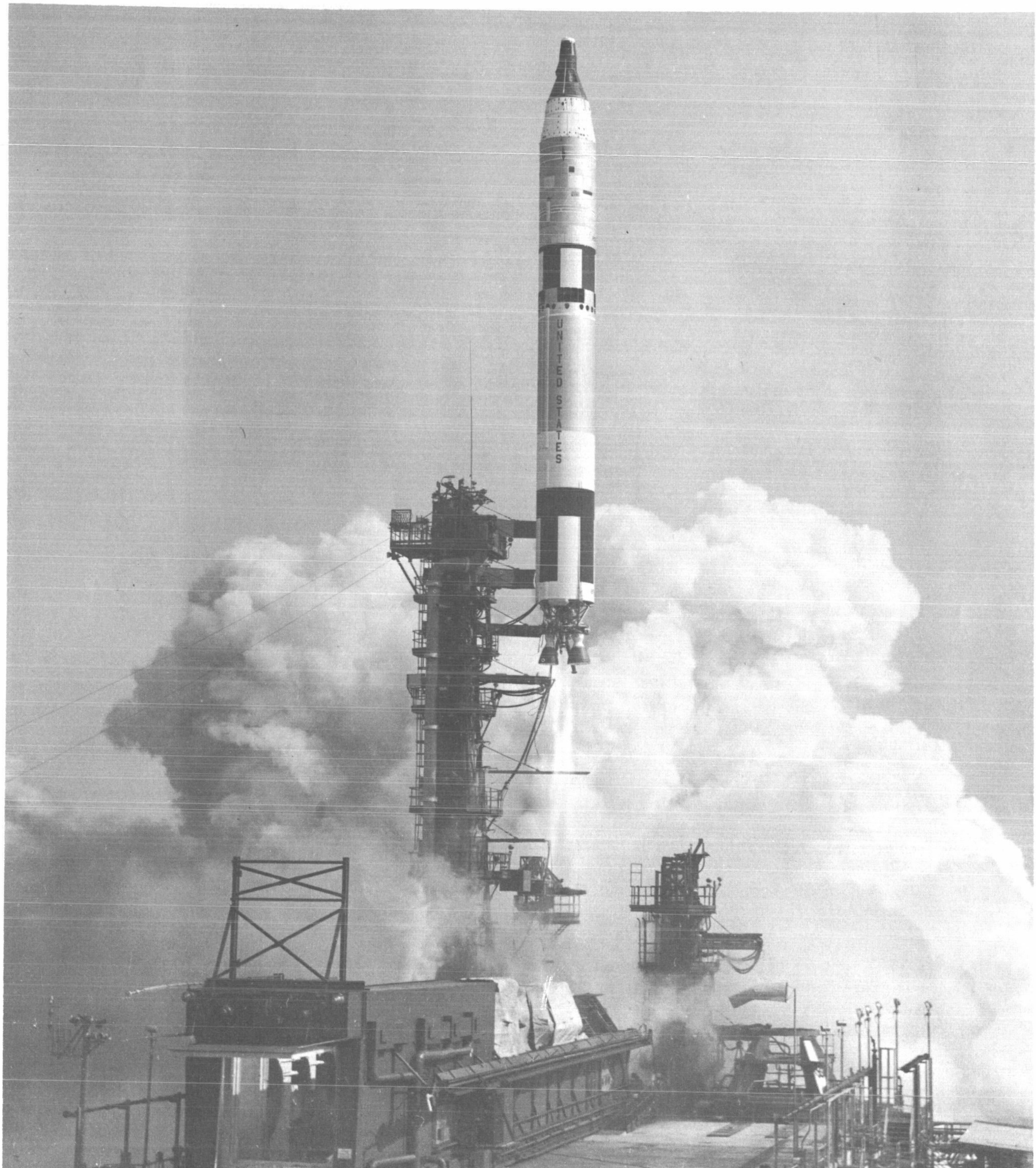
Fred Starbuck was named chief of Technical Services in the Office of the Assistant Director for Administration and Technical Services. Starbuck was to administer and direct the activities of the Facilities Engineering Division and the Experimental Fabrication and Engineering Division.

JUNE 1-6

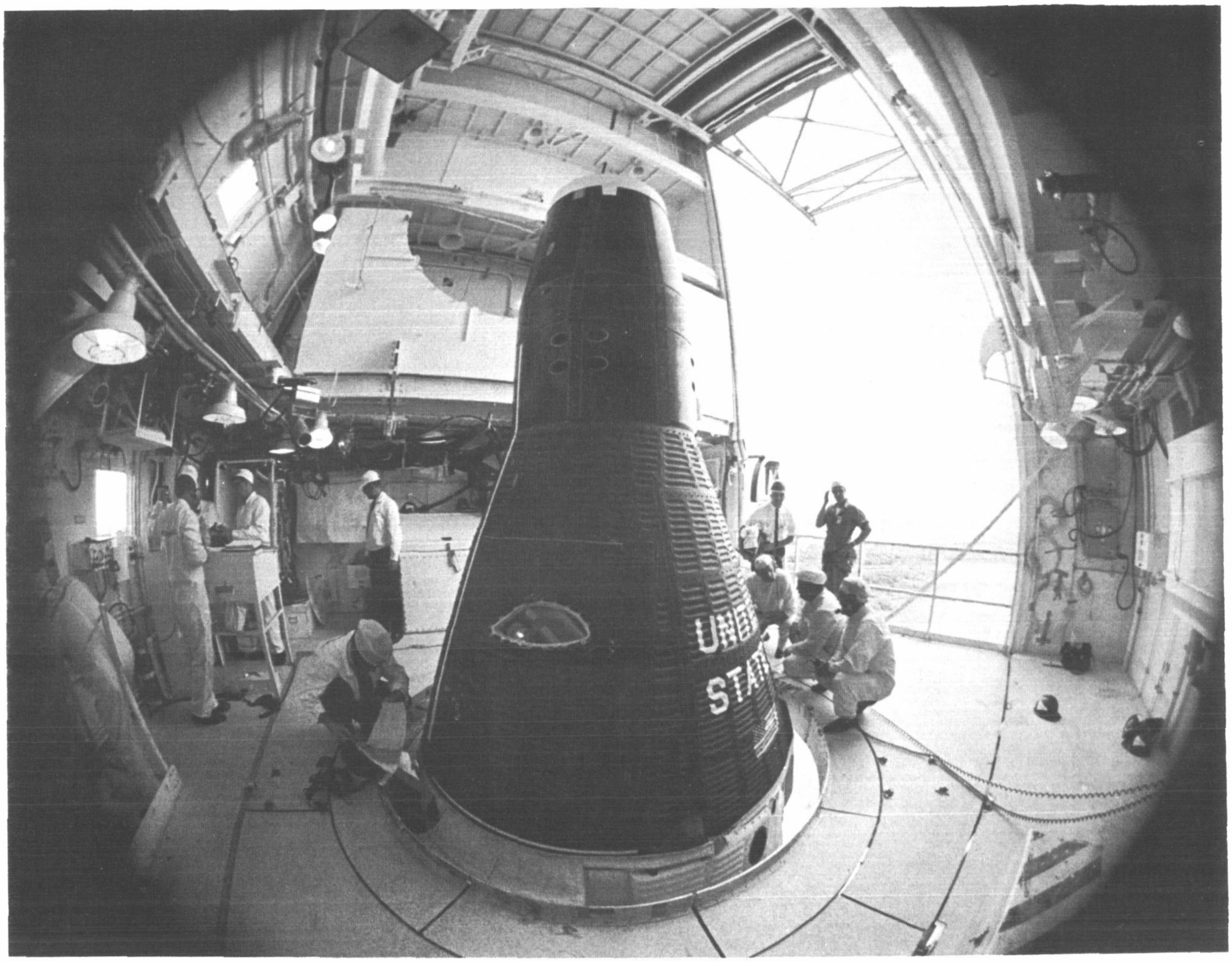
The Orbiting Solar Observatory-II, silent since it was turned off November 3, 1965, was re-activated and provided a bonus of scientific and engineering data.

OSO project officials successfully turned on the OSO-II on June 1 and obtained useful data from it before turning it off on June 6, 1966.

The spacecraft has been in orbit more than 16 months since it was launched from Cape Kennedy on February 3, 1965. Designed to operate six months, OSO-II exceeded this life expectancy by fifty percent before it was turned off in November 1965 because the gas supply for its pitch control system was almost depleted. By



A two-stage Titan II launched the Gemini 9A spacecraft at 8:39 a.m., EST, June 3, 1966 from Complex 19 at Cape Kennedy, Florida.



"Fish-eye" camera lens depicts final Gemini 9A preparations on June 3, 1966 in the White Room atop Complex 19 at Cape Kennedy. Inside the spacecraft, Astronauts Thomas Stafford and Eugene Cernan sat poised for the start of their three-day rendezvous and docking mission. The Goddard Space Flight Center is responsible for worldwide tracking and communications of all manned space missions.

saving this small amount of pitch gas, Goddard engineers made it possible to evaluate the effects of long-term space conditioning on both the spacecraft and its scientific experiments during the recent turn-on.

Goddard engineers commanded the OSO-II on by working through the Ft. Myers, Fla., station of Goddard's Space Tracking and Data Acquisition Network (STADAN). The pitch control system came on immediately and locked onto the Sun. A pitch angle of plus two degrees was achieved. Battery voltage went up to 20 volts and its charge rate was normal.

JUNE 3

Since May 20, 1966, Nimbus II obtained almost full earth data coverage with MRIR, HRIR, and AVCS. This represented simultaneous and complete pitcures of the earth in the 4 and 11 micron windows, the 6.3 micron H_2O band, the 15 micron CO_2 band and the total emitted and reflected global radiation on a daily basis for the first time.

JUNE 4

Ground breaking ceremonies for the $5.4 million Robert Hutchings Goddard Library at Clark University, Worcester, Mass.

The four-story building has been designated an international tribute to the late Dr. Goddard, America's pioneer rocket and space scientist.

Dr. Goddard, who died in 1945, earned his master's and doctorate degrees at Clark and was a member of the Clark faculty from 1914 to 1943.

The Goddard Library will also be the site for a national memorial to the famed rocket pioneer. Created by Congress and signed into law by President Johnson

last November, the national tribute is expected to be a non-representational piece of sculpture.

Participants in the ceremonies at the library site included Mrs. Robert H. Goddard of Worcester, the scientist's widow; Dr. William H. Pickering, Director of the Jet Propulsion Laboratory, Pasadena, Calif.; and Dr. Winston E. Kock, Director of the NASA Electronics Research Center, Cambridge, Mass.

JUNE 6

OGO-III (OGO-B): The observatory was launched from Pad 12 Eastern Test Range at 10:48:00:97 EDT. Preliminary orbit computations indicated an apogee height of 66,000 (66,000 nominal) n.m., perigee height of 159.57 (150.0 nominal) n.m. and an inclination of 30.97 (31.0 nominal) degrees inclination. After passing through perigee at the beginning of revolution number two, all spacecraft subsystems were performing as planned. Seventeen of the twenty experiments have been operated with no apparent anomalies. Four attempts to interrogate the range and range rate transponder had been unsuccessful and an investigation of this problem was being initiated.

JUNE 8

Orbital performance of Nimbus II continued with all sensor and spacecraft system operation without major incident. The volume of AVCS pictures exceeds twice the total number received by Nimbus I.

JUNE 10

The Orbiting Geophysical Observatory III, launched June 6, 1966 from Cape Kennedy into a near-perfect orbit was operating as planned. As of 11 a.m. 20 of the 21 scientific experiments on board the 1,135-pound observatory had been turned on and were operating, although two experiment antennas and one set of experiment sensors have not yet been deployed.

The remaining experiment, a radio propagation measuring device provided by the U.S. Dept. of Commerce's Environmental Science Service Administration, was to be turned on shortly.

Since its successful launch at 10:48 p.m. June 6, OGO III has received and carried out more than 400 different commands from the project control center.

To date, the spacecraft checkout has been relatively trouble-free. The most significant problem encountered has been the loss of signals from the on-board range and range rate tracking system.

Although this problem would jeopardize the OGO scientific mission, its cause is under study. Meanwhile an alternate tracking system employing conventional techniques was being used to determine the position in space of OGO III as it was orbiting the Earth every 48 hours and 37 minutes.

JUNE 9

High speed data tests were successfully conducted between the Vanguard Apollo Tracking Ship and Goddard. Data from the Vanguard was regenerated at the Bermuda Island Radio Relay Station and transmitted to Goddard.

JUNE 12

Operation of OGO-II from June 6 through June 12, 1966:

Commands	258
PCM Real-Time Telemetry	78 (minutes)
PCM Playback Telemetry	33 (minutes)
Special Purpose Telemetry	6 (minutes)

Repositioning of the solar array and decreasing duration of eclipses were reflected in increasing operations.

Operation of OGO-III from June 7 through June 12, 1966:

Commands	434
PCM Real-Time Telemetry	15,650 (minutes)
PCM Playback Telemetry	320 (minutes)
Special Purpose Telemetry	10,391 (minutes)

Nearly 100 percent coverage of spacecraft data was maintained during this period with dual coverage most of the time. Telemetry and command operations were normal but tracking data were very limited.

JUNE 12

Upon completion of orbit 371, approximately 0040 EDT, Nimbus II exceeded the active life of Nimbus I. The following is a comparison of the output of the two spacecraft as of this date.

	Nimbus I	*Nimbus II*
AVCS (pictures)	12,200	28,215
APT (minutes)	7,000	21,582
HRIR (minutes)	6,000	21,840
DRIR (minutes)	–	8,139
MRIR (minutes)	–	26,903

*Representing number of minutes systems were on and available for worldwide users.

MID JUNE

Operation of OGO-I experiments ceased until approximately mid-August 1966. The 136 MC/s Beacon, which had been turned off to avoid a station look angle conflict during early orbital operations of OGO-III, was turned on.

MID JUNE

The TIROS R&D site at Wallops was being disassembled.

MID JUNE

Construction of the Madrid, Spain Switching Center was 90% complete. When completed, the Madrid Switching Center will serve the Manned Flight, Deep Space, and Stadan requirements for communications from Madrid.

MID JUNE

All OGO-III spacecraft subsystems and experiments were operating satisfactorily with the possible exception of the Range and Range Rate system and the Channel Multiplier of Experiment No. 6. All experiments, except No. 14 (Lawrence, NBS), were operated in accordance with experimenters' requests. A check of the observatory indicated that Experiment No. 14 seriously interfered with the spacecraft command receiver, and therefore, would remain off indefinitely. Consumption of gas in the Attitude Control Subsystem was negligible; present gas pressure, normalized to a standard temperature of 18.5 degrees centigrade, is 2731 psia.

MID JUNE

Essential agreement was reached on implementation of a GSFC tie to the AF/ESSA/NASA/(APOLLO) Solar Event Warning Network. A network dedicated to this function was being established by the Air Force Solar Forecast Center, Ent Air Force Base, Colorado which would be used by all of these services.

JUNE 15

On June 15 between 0928Z and 1817Z, the remaining operational battery in OGO-II failed. Indication of failure was similar to a short circuit across the entire battery which could be due to serious cell reversal or the high voltage side shorted to ground. Events leading to the failure were being investigated jointly by TRW and GSFC.

This satellite, without batteries, because essentially inoperative, except for real time interrogations, until the end of the eclipse season (approximately June 23). Full sun season, which lasts approximately a month, should permit full observatory operation: once eclipses resume, operation would again become virtually impossible.

JUNE 16

The TITAN III launch was supported by GSFC Data Operations Branch. Following a successful second burn at 363.15 minutes elapsed time achieved the following synchronous orbit:

	Actual	*Nominal*
Apogee (n.m.)	18,602	18,227.5
Perigee (n.m.)	18,203.6	18,203
Inclination (deg.)	.036	.003
Period (min.)	1,350.98	

JUNE 16

The GSFC Data Operations Branch provided computer support for the TITAN III mission. Liftoff occurred at 14:00:01.084Z. The launch was nominal and the orbit achieved was the following:

	Actual	*Nominal*
h_a =	90.9 n.m.	92.3 n.m.
h_p =	89.9 n.m.	95.9 n.m.
i =	28.6 deg.	28.6 deg.
P =	87.88 min.	

First Agena burn occurred after 65.8 min. elapsed time. The burn was nominal giving the following orbit:

	Actual	*Nominal*
h_a =	18,164 n.m.	18,237.9 n.m.
h_p =	98.6 n.m.	99.5 n.m.
i =	26.4 deg.	26.4 deg.
P =	592.78 min.	

JUNE 19

TIROS VII completed 3 years of continuous operation in space. It was an axial mode type TIROS and contained 2 wide angle camera systems, a 5 channel scanning radiometer, an omni-directional (University of Wisconsin) radiometer, and an electron temperature probe. It was placed in a 58.2 angle of inclination orbit with apogee of 403 n.m. and perigee of 386 n.m.

In general, both camera systems were capable of providing good quality pictures although camera system No. 2 had malfunctioned during the period of October 15, 1965, to January 31, 1966. Some malfunction had been evident on an intermittent basis since January 31, 1966. The IR system provided over 2 years of good data. On June 19, 1965, regular interrogation of the scanning IR subsystem was terminated because 3 of the 5 sensors had degraded and 2 consecutive years of data had been obtained. On orbit 1280, September 14, 1963, the commutator of the IR telemetry subsystem stuck on the ETP terminal thereby preventing receipt of IR housekeeping data and data from the omni-directional radiation experiment. About July 16, 1963, a malfunction in a capacitor of the ETP experiment caused the loss of 50% of the data, and by January 1964 80% of the ETP data was lost. As of the above date, the spacecraft was interrogated approximately 5 times per week and the IR once per two weeks. During these interrogations it was evident that both camera systems continued to function as related above, except there was intermittent malfunction of the IR tape recorder system which was evidenced by lack of end of tape pulse and short playbacks. All five sets of spin-up rockets have been used. The current spin rate was approximately 6.0 rpm and decreasing at the rate of .4 rpm per month. A "successful" failure in the spacecraft subsystems occurred after 12 months when the one-year timer for beacon shut-off did not perform. This failure allowed continued receipt of beacon signal and spacecraft housekeeping data valuable in tracking and analyses of the operation of the satellite. Failure of the beacon timer was probably due to failure of the self-contained batteries.

Over 120,000 pictures have been received from approximately 14,000 orbits. 2,849 orbits of radiation data were successfully reduced ending on orbit 10,812 on June 19, 1965. Data from the 8-12 and .55 - .75 micron channels caused the data to be unusable at earlier dates (8-30 micron February 23, 1964, 14.8-15.5 micron—November 14, 1964; 0.2-6.0 micron, December 25, 1964).

Data from pictures were used operationally until the launch of TIROS IX on January 1965 and intermittently for fill-in after that date. TIROS VII observed every major hurricane, typhoon, and tropical strom which occurred during its three years of operation, and was first to discover Hurricanes Arlene, Beulah, Debra, Edith and Flora during the 1963 hurricane season. A total of 3,683 nephanalyses have been prepared from TIROS VII picture data, and a total of 630 special storm bulletins have been sent to stations all over the world.

In addition, TIROS VII data have been used to support:

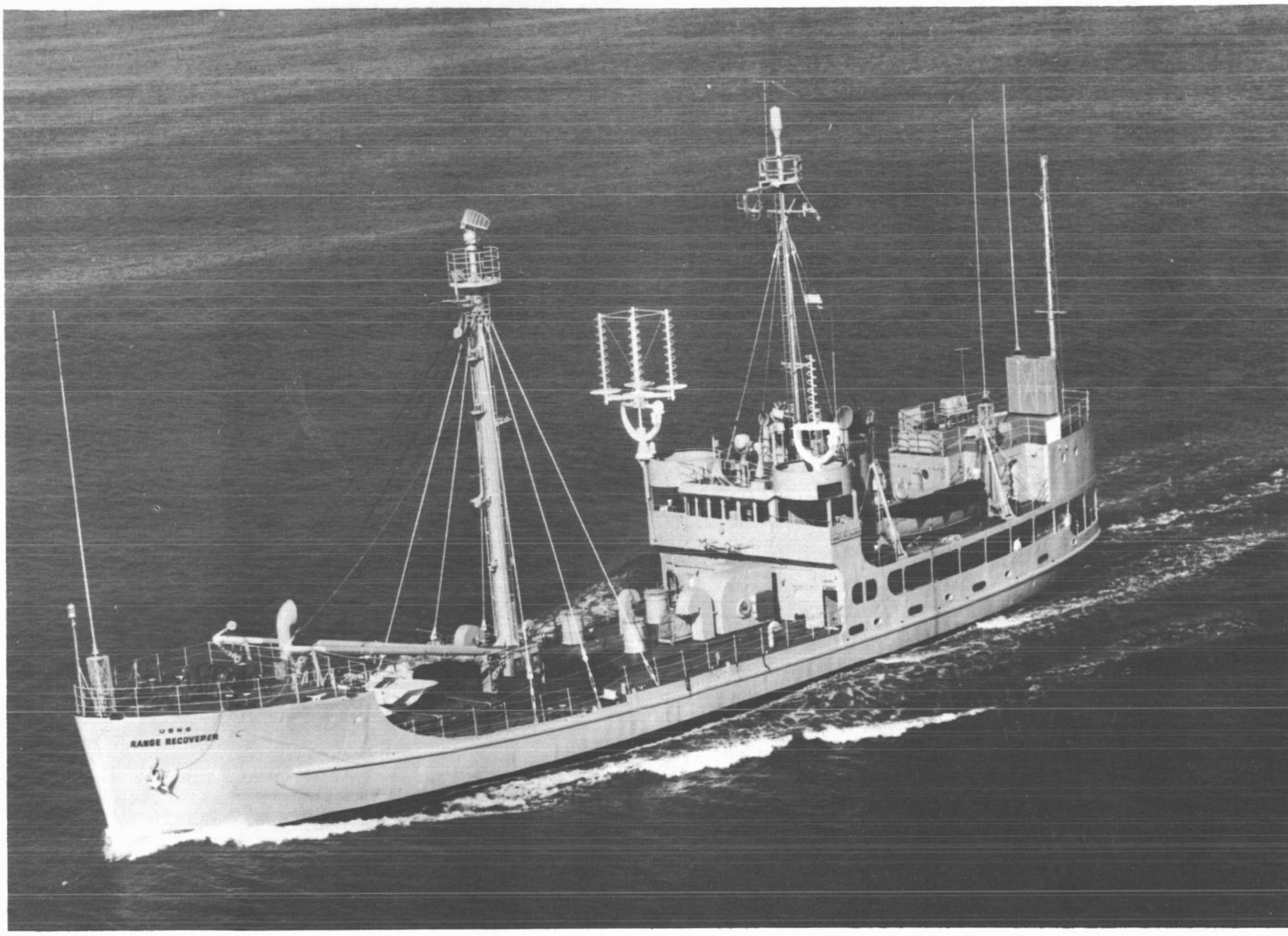
Manned Spacecraft Missions
Antarctic Resupply Missions
International Indian Ocean Expedition
U.S.A.F. Detachments
Ice Reconnaissance
Special IR Studies

The IR data have been analyzed by many agencies, universities, and private research laboratories including universities in Germany, Italy, Argentina and Japan. The data have been of great value in carrying out studies in the (1) planetary heat budget, (2) stratosphere temperature patterns and dynamics inferred from them, (3) mapping of weather systems on meso, synoptic, and quasi-global scales, and (4) mapping of sea surface temperature. A number of papers have been given at various scientific meetings and have been published in appropriate scientific media.

JUNE 21

STADAN Support Summary for the week June 14th to June 21.

Name	TLM Passes Supported	MINS Data Recorded	TRK Passes Supported	M/T Messages	R & RR Messages	X-Y Messages	Optical Messages
ALOUETTE-A	67	620	20	18			
TIROS VII			25	24			
SN/39	59	868					
TIROS VIII			26	26			
RELAY II	54	2021	91	89			
ECHO II	1	0	54	0			
OGO-A	1	30	11	2			
BE-B	100	1597	67	67			
AIR DENSITY			106	97			
INJUN	76	1532	29	28			
EPE-D	67	10275	48	48			
TIROS-IX			41	30			
OSO-B	NO SCHEDULED OPERATIONS						
PEGASUS-A	102	1263	48	47			
EGRS III			42	22			
BE-C	35	667	56	44			
PEGASUS-B	100	1265	48	48			
IMP-C	23	11638	29	14	12		
TIROS X			59	56			
PEGASUS-C	102	1133	54	53			
EGRS-V							
OGO-C	48	58	83	75			
GEOS-A	28	608	451	264	40		56
IQSY	98	1615	87	86			
ALOUETTE-B	102	1595	39	34			
DME-A	55	224	19	9			
FR-1A	155	2694	106	106			
ESSA-1			102	55			
ESSA-2			171	129			
OAO-A1	86	0	156	1			6
NIMBUS-C	124	1770	119	112			
AE-B	152	664	114	66		2	
OGO-B	57	10543	577	8	57	272	
EGRS-VI	16	437	174	82			
ORS-II	8	91	134	77			
TOTAL	1,716	53,208	3,186	1,817	109	274	78



The USNS Range Recoverer was the site of the successful launch of 5 sounding rockets during the solar eclipse studies conducted near Greece.

JUNE 22

Herbert I. Butler, Chief of Goddard's Operational Satellites Office, officially turned a new Command & Data Acquisition (CDA) Station over to the Environmental Science Services Administration. The construction of the station was contracted for and managed by the Goddard Space Flight Center.

The new CDA station–which controls the spacecraft and receives stored data gathered by the United States operational weather satellite system–was dedicated in ceremonies at Wallops Station, Virginia.

Construction of the $4.4 million ESSA CDA station began on March 18, 1965. The station includes an 85-foot parabolic antenna and its associated electronics equipment through which signals are sent to and received from the spacecraft.

With a staff of 52 people, the Wallops CDA station operates 24 hours a day throughout the year.

The operational weather satellite system was composed of two spacecraft–ESSA-1 and ESSA-2, both launched in February 1966–which provide almost total coverage of the earth's weather every day. ESSA-1 stores its photographs for readout by large CDA stations, while ESSA-2 sends local pictures directly to simple receiving stations around the world.

JUNE 22

The first attempts to pass Apollo Launch Data System ALDS over the GSFC high speed 490 to 7094 interface were tried.

JUNE 23

Explorer XXVI (EPE-D) transmitted satisfactorily for one and one-half years. During this time it supplied 10,000 minutes of recorded data per week.

JUNE 24

The Data Operations Branch provided computing support for PAGEOS. PAGEOS-1 (1966-56A) was launched from the Western Test Range aboard a Thrust Augmented Thor/Agena-D launch vehicle at 00:12:02Z. Due to a failure of the commercial telephone high speed trajectory data line between GSFC and WTR Range Operations Computing Center no data reflecting the launch was received at GSFC in realtime.

JUNE 27

All Nimbus II spacecraft systems were performing satisfactorily. At orbit 501 the cumulative data to date was:

AVCS	12,981 frames
HRIR	351 hours, 18 minutes
MRIR	654 hours, 22 minutes
APT	632 hours, 41 minutes
DRIR	227 hours, 49 minutes

JUNE 29

All flight experiments for OSO-D were installed in the spacecraft and ready to start compatibility tests except for a noise interference problem with the Harvard College Observatory experiment. A February 1967 launch was anticipated.

JUNE 30

The GSFC Procurement Division ended the 1966 Fiscal Year with over 30,000 contractual actions involving obligations in excess of $470,000,000.

LATE JUNE

Operation of OGO-I experiments ceased until approximately mid-August 1966. Monitoring of signal strength of AGC (136 MC Beacon) was continued.

LATE JUNE

OGO-II operation of experiments was resumed during Revolution 3483.

EARLY JULY

During early July 1966 the Optical Systems Branch's laser ranging system was shipped to NASA Data Acquisition Facility, Rosman, North Carolina, to compare the accuracy of laser ranging against Goddard Range and Range Rate System. The laser ranging system was installed and was being checked out. Preliminary laser tracks were made against the GEOS satellite. Over 100 range data points had been recorded and believed accurate to better than 20 meters.

JULY 9

It was announced that NASA hired the services of the Communications Satellite Corp. (COMSAT) in support of the Apollo astronaut program Friday for a fee of $8,950,000 a year.

COMSAT will provide voice-data and teletype channels, for communication with Apollo orbital and lunar flights, by means of synchronous satellites to be positioned 22,300 miles above the Pacific and Atlantic oceans.

NASA said the Atlantic satellite would serve ground stations at the Grand Canary and Ascension Islands, and two tracking ships to be stationed in the Atlantic and Indian oceans.

The Pacific satellite will serve a station at Carnarvon, Australia and a tracking ship in the Pacific Ocean.

JULY 14

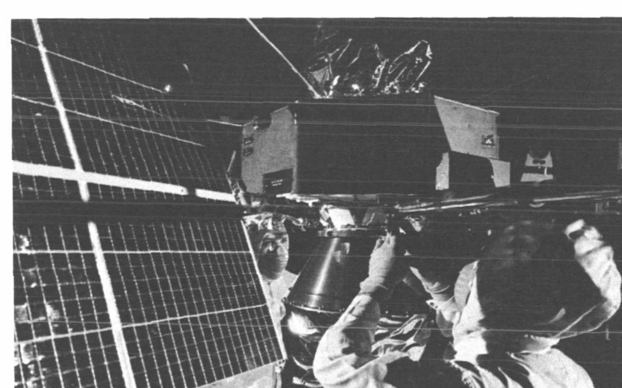
NASA launched a German experiment on a Nike-Apache sounding rocket from Wallops Island, Va., in a cooperative program to measure electron density in the ionosphere. A variable frequency impedance probe provided by Prof. Karl Rawer, director of the Ionospheric Institute of Breisach, Germany, soared to 121 statute miles. Total payload weight was 52 lbs.

NASA participation in the project was the responsibility of Goddard Space Flight Center under the direction of Dr. Siegfried Bauer of the center's Planetary Ionosphere Branch. Leo Blumle was project scientist. Germany and NASA are also cooperating on a pair of sounding rockets, a Javelin and Nike-Tomahawk, to be launched this fall from Wallops to study comets, the interplanetary medium and the earth's magnetosphere.

JULY 18

The Goddard Data Operations Branch supported the Gemini GT-10 mission. The Atlas Agena 10 lifted off at 20:39:46Z 18 July 1966, and was inserted into a 161 n.m. circular orbit. GT-10 lifted off at 22:20:26Z precisely on time and was inserted into a 86.6/144.5 n.m. orbit. Agena 8 target vehicle slated for a rendezvous exercise was in a 214 n.m. circular orbit. The reason for the late afternoon liftoff and 32 second launch window was the fact that Agena 10 target and GT-10 had to be placed in the plane of the Agena 8 orbit so as not to require large plane change maneuvers which require large amounts of fuel to rendezvous. At insertion GT-10 trailed Agena 10 by approximately 1000 n.m., GT-10 trailed Agena 8 by approximately 5100 n.m. and Agena 10 trailed Agena 8 by approximately 4100 n.m. The major objectives of the mission were realized, the docking with the Agena 10, rendezvous with Agena 8, standup EVA, the umbilical "Space Walk" and the new altitude record of 411.8 n.m.

The GLV booster reentered in the Indian Ocean at 8:05 p.m. EDT on 19 July 1966.



Checkout of the 206-pound Anchored Interplanetary Monitoring Platform (AIMP) satellite.

MID-JULY

The IMP III spacecraft continued to transmit satisfactorily. A total of 377 hours of data was recorded during the period June 27 through July 10, bringing the total to 11,232 hours of data recorded.

JULY 15

Nimbus II, the largest weather satellite ever launched, passed its final test objective of two months of continuous operation. Launched from the Pacific Missile Range on May 15, 1966, it was being readied for extensive infrared photo coverage of hurricane breeding areas in the Atlantic Ocean.

Since going into orbit, the satellite had traveled more than 20 million miles, had taken more than 150,000 pictures and had received more than 23,000 commands, or instructions, from ground controllers.

JULY 19

Dr. Robert E. Hunter, formerly of the Air Force Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio was appointed Head of the Auxiliary Propulsion Branch, Systems Division. Dr. Hunter replaced Mr. Alton E. Jones, Associate Division, who had been Acting Head of this Branch. Mr. Jones continued as Associate Chief, Systems Division.

JULY 24

A special train carrying the 40-foot dish antenna assemblies and parts arrived at Tananarive, Madagascar from the Port of Tamatave.

JULY 25

Camera system 2 of ESSA-1 failed on orbit 2468, July 25. In both the remote and direct mode, the system produced black frames indicating a failure in the voltage regulator or the filament of the vidicon. Camera system 1 continued to perform normally. The spacecraft had been in orbit over 5½ months. More than 35,000 pictures had been produced by the camera system 1. TIROS IX was being maneuvered into the best attitude to supplement pictures from camera system 1 of ESSA-1. NESC/ESSA was maintaining control of both ESSA-1 and TIROS IX.

JULY 26

Orbiting Geophysical Observatory III was commanded into a spin-stabilized mode after a malfunction of the attitude control system.

The satellite was launched from Cape Kennedy, Fla., into a nearly-perfect elliptical Earth orbit last June 6. It operated almost flawlessly in an Earth-stabilized mode for more than six weeks, thus proving the engineering feasibility of the three-axis stabilization system. Operation in this mode for 30 days was one of the two primary mission objectives.

JULY 28

A series of upper atmosphere experiments with the support of space research groups in Brazil and Canada were announced. The launchings were to be made when noctilucent clouds occur.

Ten Nike-Cajun sounding rockets, carrying 80-pound payloads to obtain synoptic meteorological data, will be launched from four widely separated sites in the western hemisphere—Natal, Brazil; Churchill Research Range, Canada; Point Barrow, Alaska, and Wallops Island, Virginia.

The launchings were to be conducted over a 24-hour period, beginning at midnight whenever noctilucent clouds appear over the Churchill area. Noctilucent clouds are visible at night because of sunlight reflected off small particles of matter in space.

The Brazilian Space Commission will conduct the launching from the Natal range. The Churchill Research Range is operated under a cooperative arrangement between NASA and the Canadian National Research Council.

The project was to be coordinated by Wendell S. Smith, Project Scientist at GSFC. Roger Navvarro was to be the Project coordinator for the launchings at Wallops Island. Wallops Station personnel, headed by William A. Brence, was to conduct the launchings at Point Barrow.

LATE JULY

The housekeeping PCM tape recorder of Nimbus II failed to respond to a command for playback during orbit 949. Subsequent efforts to achieve playback have been unsuccessful. Prime suspects as the source of failure are: tape failure, motor stall, or playback amplifier failure.

At the request of ESSA, Nimbus II AVCS was being transmitted by wideband link to Suitland, Maryland to support operational requirements, pending the launch of TOS A.

JULY 31

During the month of July, the STADAN stations recorded 7,822 minutes of telemetry data from EXPLORER 22. The spacecraft successfully completed its 9,065 orbit on this date. The ionosphere beacons continued to operate satisfactorily.

During July EXPLORER 27 operated continuously on all seven transmitting frequencies. The STADAN stations recorded 2,677 minutes of telemetry data during this period. The spacecraft successfully completed its 6,126 orbit.

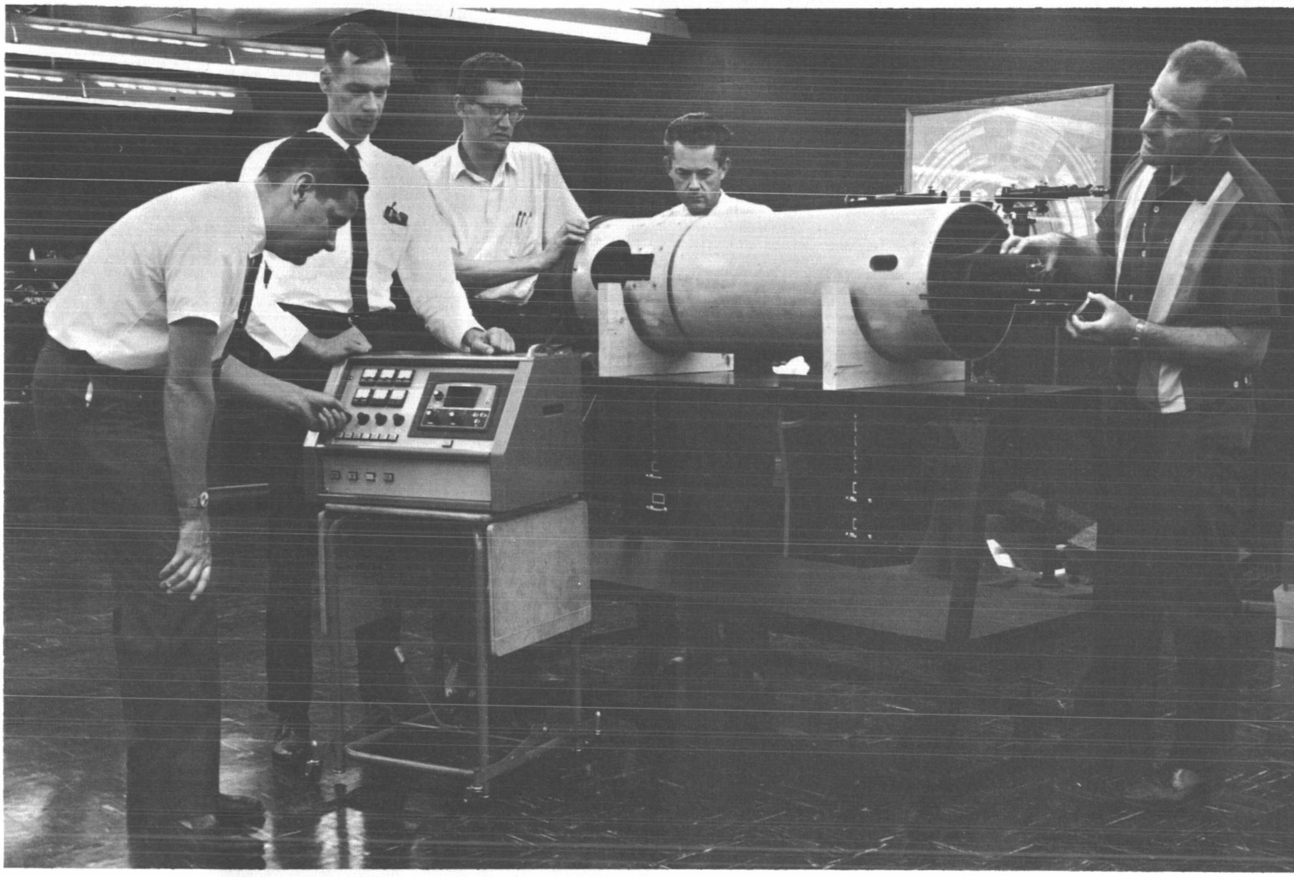
EARLY AUGUST

The FR-1 satellite completed 276 days of successful operation.

AUGUST 2

NASA began negotiations to renew a contract with the Radio Corporation of America Service Company, Cherry Hill, N.J., for operation and maintenance of three data acquisition facilities. The cost-plus-award-fee contract was expected to cost more than $13 million.

RCA's initial contract in 1963 covered a period of two years while the facilities were still being developed and totaled $8.6 million. In June 1965, it was extended one year for an additional $7.4 million. The current renewal runs from July 1, 1966, through September 30, 1967.



Members of the Astrophysics Branch checkout a STRAP sounding rocket payload in the Optical Alignment Room. Shown (left to right) are Gerald R. Baker, James L. Shannon, Theodore P. Stecher, Alfred K. Stober and Reuben Scolnik.

The contract extension called for engineering and operations services for the Data Acquisition Facility (DAF) portion of NASA's unmanned Space Tracking and Data Acquisition Network (STADAN), operating weather satellite control centers at the Goddard Space Flight Center, Greenbelt, Md., and operating and maintaining tracking stations at Rosman, N.C. and Fairbanks, Alaska. The two stations now have 85 ft. electronic antennas for tracking and receiving information from unmanned satellites.

AUGUST 3

While two tape recorders in the Nimbus II weather satellite had gone out of action, the 912-pound experimental spacecraft continued to transmit daytime and nighttime cloud cover pictures.

Launched May 15, 1966, the spacecraft had met all mission objectives and had taken more than 200,000 photographs of the weather on a global scale.

One of the tape recorders which failed was used to store data from the Medium Resolution Infrared Radiometer (MRIR), the other is used in measuring the engineering performance of the satellite.

AUGUST 3-5

High speed data tests at 600, 1200 and 2400 bits per second were conducted from the Apollo Tracking Ship "Vanguard" to Bermuda during the Vanguard's sea trials. Average bit error rates were 1 in 10^4 and 5 in 10^4 at 600 and 1200/2400 bits per second respectively. The system was acceptable for Apollo data.

AUGUST 9

The first complete network test of Apollo 202 High Speed Data System involving Houston, Goddard, Carnarvon, and KSC was conducted. The test was considered highly successful. Command data from both the Houston and Goddard Real Time Computer Centers (RTCCs) was transmitted to the 642B computers in GSFC's University Building. The University Building was used to represent Carnarvon, since the programs were not available at Carnarvon. It was the first attempt to transfer command data from a 7094 to a 642B computer.

Also, for the first times Carnarvon Unified S-Band tracking data was transmitted through the Goddard 490

Communications Processors to both the Goddard and Houston RTCCs.

AUGUST 10

The GSFC Data Operations Branch provided computing support for Lunar Orbiter. The Agena orbit determined on the basis of this data was the following:

	ACTUAL	NOMINAL
h_a =	169,772 n.m. apogee	193,322 n.m.
h_p =	98.8 n.m. perigee	100 n.m.
e =	.9599 eccentricity	.965
P =	10,983 min. period	13250 min.
i =	29.57 deg. inclination	29.39 deg.

The Center also provided communication support for the unsuccessful Lunar Orbiter A launch attempt on August 9, and the successful launch on Aug. 10. Communications to the Deep Space Network were good throughout the launch and cruise phases, with only minor outages experienced. Deep Space Stations at Woomera, Johannesburg, Goldstone, and Cape Kennedy were prime. Madrid and Ascension participated in a training status. GSFC continued to provide communications during the cruise mode for what appeared to be a very successful mission.

AUGUST 10

Erection of the Minitrack antennas was completed at Orroral, Australia

MID-AUGUST

The GSFC Data Operations Branch used Lunar Orbiter (launched August 10, 1966) as a target of opportunity to exercise the Apollo USB sites. With the exception of about eight hours after midcourse correction acquisition data was sent continuously to the following USB sites:

Merritt Island	Guam	Antigua
Bermuda	Guaymas	Grand Bahama Island
Carnarvon	Ascension	Canary Island
Texas	Hawaii	

The acquisition data included the full lifetime around the moon. The orbit has a 102 n.m. perigee and 1007 n.m. apogee around the moon. Picture taking commenced at 10:42 a.m. EDT August 18, 1966 and was transmitted back to Pasadena, Calif. JPL later that date.

Goddard's NASCOM Division provided communications to Deep Space Stations participating in the Lunar Orbiter mission.

A serious brush fire in Madrid occurred during the deboost maneuver affecting the communications cable between the NASCOM Switching Center and Madrid. However, radio facilities were immediately available as back up and the mission was unaffected. The Spanish Telephone Company rapidly restored the cable to service as soon as the fire had burned past the cable path. The cable was operating by midnight, August 14.

AUGUST 16-17

The AS-202 communications network configuration was tested. Involved was the transmission of data to Carnarvon and Houston via the Goddard 409 Communications Processor and the Goddard 7094 computers. An electrical storm in the area caused both Goddard 490s to fault. During recovery, a program bug was discovered and corrected. All data looked good with acceptable bit error rates. Confidence tests were continuing.

AUGUST 17

Tape recorder operation for AE-B ceased because of extremely high data loss being experienced during tape recorder playback cycles.

AUGUST 17

Delta 40 successfully placed the *Pioneer B spacecraft* into a heliocentric orbit.

AUGUST 17

The second Aerobee 350, a new high-performance research rocket was launched from the NASA/Wallops Station. The 53-foot rocket carried more than 400 pounds of instruments for a dual-purpose engineering-space science mission.

The prime purpose of the launch was to evaluate performance of the Aerobee 350, features a main stage comprised of four liquid fuel Aerobee 150 engines and a solid-fuel Nike booster. The rocket develops 60,000 pounds of thrust. The first full-flight test of the rocket, conducted in June 1965, checked its flight characteristics and demonstrated capabilities as a sounding rocket.

This mission was the first use of the Aerobee 350 for space research. Three scientific experiments were carried, accounting for nearly half of the payload instrumentation. The NASA Goddard Space Flight Center conducted an experiment to measure the effects of the Earth's ionosphere and magnetic field on radio frequency antennas.

The information will be needed for interpretation of radio emissions to be studied by the future Radio Astronomy Explorer satellite.

Another Goddard experiment was designed to measure X-ray emissions from the Sun and Crab Nebula. The third experiment was carried for the University of Minnesota, for the purpose of gathering data on electric waves in the ionosphere.

The Aerobee reached a peak altitude of 222 miles and impacted in the Atlantic Ocean about 106 miles from the launch site. Approximately 13.5 minutes of rocket performance and experiment data were sent back from the flight by telemetry.

John H. Lane, NASA Aerobee 350 Project Scientist, indicated that preliminary examination of vehicle data indicated the rocket's performance was very close to predicted.

AUGUST 18

The Soviet Union has begun transmitting to the United States information obtained from its weather satellite Cosmos 122.

This is the first time the Soviet Union used the "cold line" weather link between Moscow and Washington to transmit data from the weather satellite.

The surprise move cheered U.S. weather officials. They hoped it meant the beginning of close cooperation between the two countries in amassing weather information.

First indication that the Soviet Union was ready to use the weather line to relay satellite data came when these words clattered over a teletype machine in the U.S. National Environmental Satellite Center in Suitland, Md.:

"U.S.S.R. Hydrometeorological Center begins experimental transmissions most interesting meteorological information received from earth satellite Cosmos 122."

Cosmos 122 was the only known operating Soviet weather satellite. It was launched June 25, 1966.

The message then reported data picked up by Cosmos 122. Since then, further information has been transmitted over the line. Subsequently, seven weather maps were received.

An agreement between the two countries, reached in 1962 and expanded in 1963 and 1964, provided for exchange of weather satellite data over the telecommunications channel between Washington and Moscow. However, the Russians transmitted only conventional observations—from land stations, ships and balloons.

MID AUGUST

The Satellite Telemetry Reduction Integration Processing System (STRIPS) complex which was designed to edit, decom, calculate and merge attitude for the DME-A spacecraft became operational. The acronym STRIPS was selected in deference to the shopping list techniques used in decommutation. This technique allows experimenters to "strip" from the Univac 1107 drum any of the various housekeeping orbit, or attitude parameters he wishes to include with his data.

MID AUGUST

The 85-foot Rosman antenna system no. 2 was declared operational for network scheduling, including ATS tests, flybys, and simulations. Since acceptance from the antenna installation contractor, this antenna was used previously for short periods to support OAO, OGO, and NIMBUS passes.

MID AUGUST

The NIMBUS II spacecraft performance continued to provide the established level of sensor data. At the end of orbit 1353 the automatic vidicon system had produced 105,000 pictures.

Support data continued to be forwarded to ESSA. As a result of their requests the size of the grid points was being doubled and grid point spacing changed from 2 degree to 5 degree intervals.

MID AUGUST

Degradation of the solar aspect, coupled with lengthening eclipses, resulted in reduction of acquisition of experiment data to approximately fifty percent of available OGO-II coverage. Within approximately two weeks, operation of OGO-II was expected to be curtailed to one or two days per week until an array slew to the 180-degree position. Following this slew, operation of the observatory was essentially for housekeeping purposes for one or two months until the observatory entered another period of high power.

MID AUGUST

The Deputy Administrator approved the German Research Satellite-A (GRS-A) Project June 15, 1966 to perform an integrated study of energetic particles in the earth's inner radiation belts and the assignment of project management responsibilities to Goddard. Phase I is the Sounding Rocket Program to test the functioning of proposed satellite instrumentation and to verify the performance of the proposed satellite experiments. Phase II is the injection into orbit and operation of a satellite to carry out experiments to achieve the scientific objectives of the mission. After implementation of Phase I the German Project team is to submit a description of the experiments to be carried and of the scientific objectives as well as a technical description of the satellite. After evaluation of this project plan by Goddard and NASA Headquarters, approval will be obtained from the Space Science Steering Committee to proceed with the satellite plan.

AUGUST 25

The Goddard Data Operations Branch provided computing support for the AS-202 mission. It provided acquisition data to the MILA and Bermuda USB antennas for the launch phase and to the Ascension and Carnarvon antennas for the launch phase and to the ASC and GRO antennas for the free flight phase. MILA and BDA tracked during the powered flight phase but we received no valid 2-way doppler track in unpowered flight.

Liftoff occurred at 17:15:32 Greenwich meantime. The launch phase appeared nominal up to SIVB cutoff. The cutoff appeared 12 seconds earlier than expected. The service module engine was fired four times during the flight. Maximum altitude achieved was approximately 630 n.m. The spacecraft, a lifting vehicle with a nominal foot print of 2400 n.m. as compared with Gemini 400 n.m. landed about 200 n.m. short of the target and 120 n.m. south of the ground track.

AUGUST 28

During revolution 272 the solar array of OGO-I was rotated from 206° to 227°, a more favorable solar aspect; this solar aspect was expected to provide sufficient power to start limited operation of experiments.

LATE AUGUST

Installation of a voice/data switchboard at Madrid was completed.

AUGUST 31

The following organization and personnel changes were announced at the GSFC: The Administration and Technical Services Directorate was renamed: Administration and Management Directorate. Dr. Michael J. Vaccaro and Mr. Bernard Sisco continued as Assistant Director and Deputy Assistant Director, respectively.

Within the Office of the Assistant Director for Administration and Management, the following positions were established: Samuel W. Keller was appointed Deputy Assistant Director for Administration, with responsibility for administrative management support, supply and technical information. Leon M. Schwartz, former Assistant for Systems Analysis, was appointed Chief of Program Review and Resources Management, with responsibilities for functional management of Center resources, business support of programs and projects, and program analysis and reporting.

Fred Starbuck continued as Chief of Technical Services, with responsibility for the facilities engineering, experimental fabrication support, and plant operations and maintenance functions. Richard Keegan, Deputy Chief of the Procurement Division was appointed Chief of that Division. Edward T. York, Jr., formerly Assistant Chief of the Procurement Division for Staff Operations and Industry Relations was appointed Chief of the Program Support Division. James R. Keene, former Acting Chief, Organization and Personnel Division, was appointed Chief, Manpower Utilization Division (formerly the Organization and Personnel Division).

The former Plant Operations and Maintenance Branch, Facilities Engineering Division, was established as the Plant Operations and Maintenance Division. Loyd T. Payne, Head of the Former Branch was appointed Chief of the newly established Division.

Gordon H. Tyler, formerly Chief of the Goddard Center's Procurement Division was named assistant director of procurement for policy and review, at NASA Hqs.

AUGUST 31

The following key appointments were announced: Mr. Robert R. Ziemer was appointed Deputy Assistant Director for Projects, Projects Directorate, and Joseph Purcell, who had headed the Space Electronics Branch, Information Processing Division, Tracking and Data Systems Directorate, was appointed Project Manager, OAO Project.

AUGUST 31

OGO-I. During Revolution 273, the OGO-I solar array was rotated from 227°, to 255°, a more favorable solar aspect. This solar aspect increased the average power to 4.5 amperes, sufficient for turn-on of experiments and acquisition of 24 hours of experiment data into data storage during Revolution 273. As power continued to increase, the orbital coverage of approximately twenty (20) percent in realtime and thirty (30) percent into data storage was increased.

SEPTEMBER 4

Operations of the OGO's from 29 August through 4 September.

OGO I

Commands	633
PCM Real time telemetry	164 minutes
PCM Playback telemetry	23 minutes

OGO III

Commands	869
PCM Real time telemetry	187 minutes
PCM Playback telemetry	71 minutes
Special Purpose telemetry	62

OGO III

Commands	467
PCM Real time telemetry	1384 minutes
PCM Playback telemetry	151 minutes
Special purpose telemetry	181
Range and Range Rate (R&RR)	8.7

MID SEPTEMBER

The Minitrack antennas at Blossom Point Stadan Station have been dismantled.

SEPTEMBER 20

The Goddard Data Operations Branch provided computing support for Surveyor B (AC-7). Liftoff of the Atlas Centaur occurred at 12:32:00Z from ETR on an azimuth of 114.36 degrees. The MSFN sites supporting were BDA, CYI, KANO and CRO. During the launch and Centaur burn everything appeared nominal. A mid-course correction of about 1 meter per second was required. When mid-course correction was attempted only two out of three of the correction rockets fired causing a rapid tumbling of the spacecraft beyond the capability of the attitude control jets to correct. This failure could not be corrected and prevented a soft landing on the moon.

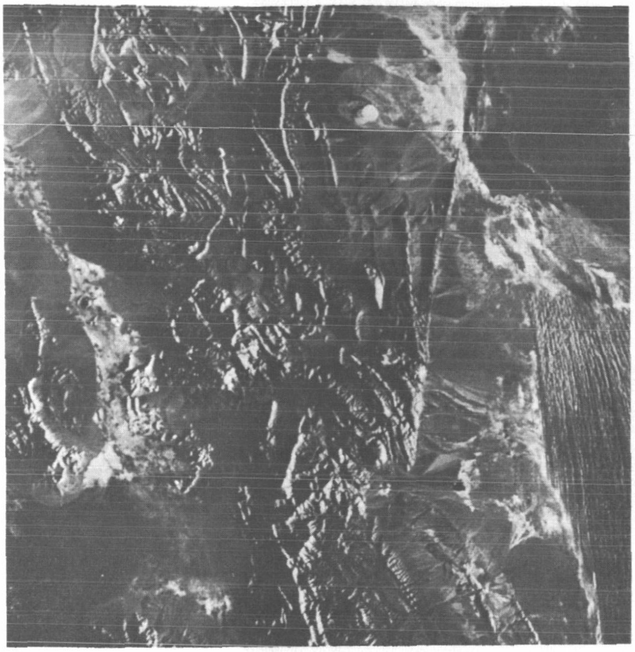
SEPTEMBER 26

Ralph W. Tyner was appointed Industrial Relations Officer, a newly established position on the Staff of the Administration and Management Directorate. In this capacity, Mr. Tyner was to serve as the focal point for all matters involving and relating to labor and industrial relations.

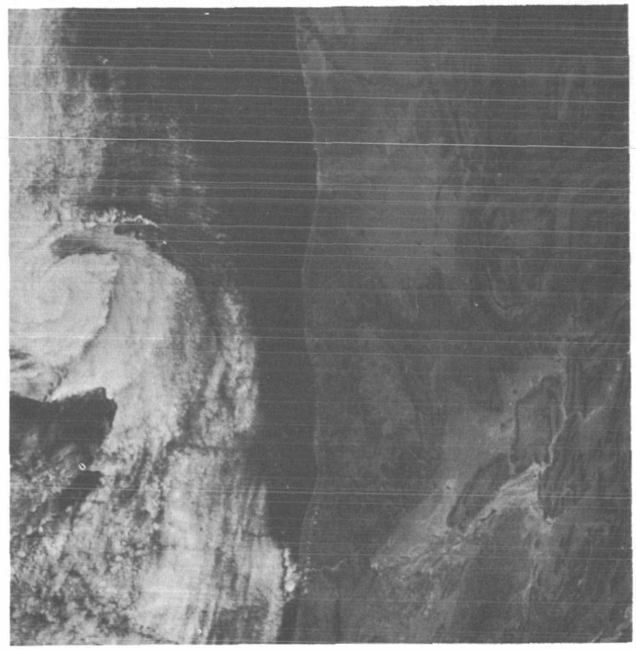
SEPTEMBER 26

TIROS VII was programmed for both TV pictures and IR readout, orbit 17662 after 1191 days in orbit. Excellent pictures were received from camera system 1. Black pictures were received from system 2. The pictures showed evidence of wobble in the spacecraft. The spin rate is about 4.0 rpm. The IR readout was

GEMINI ASTRONAUTS SERVE AS CAMERMEN FOR GODDARD'S SYNOPTIC TERRAIN PHOTOGRAPHY



The Eastern Zagros Mountains in Iran. Jagged up-and-down structure at lower right is probably a dry salt lake running for over a hundred miles, the remains of an ancient sea.



Fearsome looking cloud formation at left actually caused no storm damage. This giant whirlpool design was photographed between the Azores and Morocco. The convoluted structures are folded sedimentary rock in the Anti-Atlas Mountains.

normal–3 min. 40 sec. The IR tape recorder functioned properly. It essentially was the same recorder as used in the Nimbus MRIR experiment.

SEPTEMBER 26

At the Madagascar Stadan Station the telemetry system and telemetry building was declared ready for operational use. This position utilized a SATAN antenna system operating in the manual mode until receipt of the planned tracking receiver. Test tapes were successfully run to check out the other two telemetry positions utilizing all available installed equipment.

SEPTEMBER 29

Commencing with September 29 and continuing through October 15, 1966, the Data Operations Branch was to provide computing support for the Network Simulations (NS-2). These Apollo simulations were to provide training for Apollo Flight Controllers for the AS-204 mission and exercise the new elements of the Apollo Network. The Remote Site computing programs for the Univac 642B computers were to be exercised for the first time in a mission mode. These included the Command and Telemetry Programs for Apollo Flight Controller Sites and Remoted Sites.

Of special significance to Goddard was the fact that the Network Support Team (NST) was to attempt to operate from Goddard Building 14 instead of the control center at MSC. This group was to manage the Apollo network during mission time. If successful, management of the Apollo network from Goddard for all Apollo missions was a possibility.

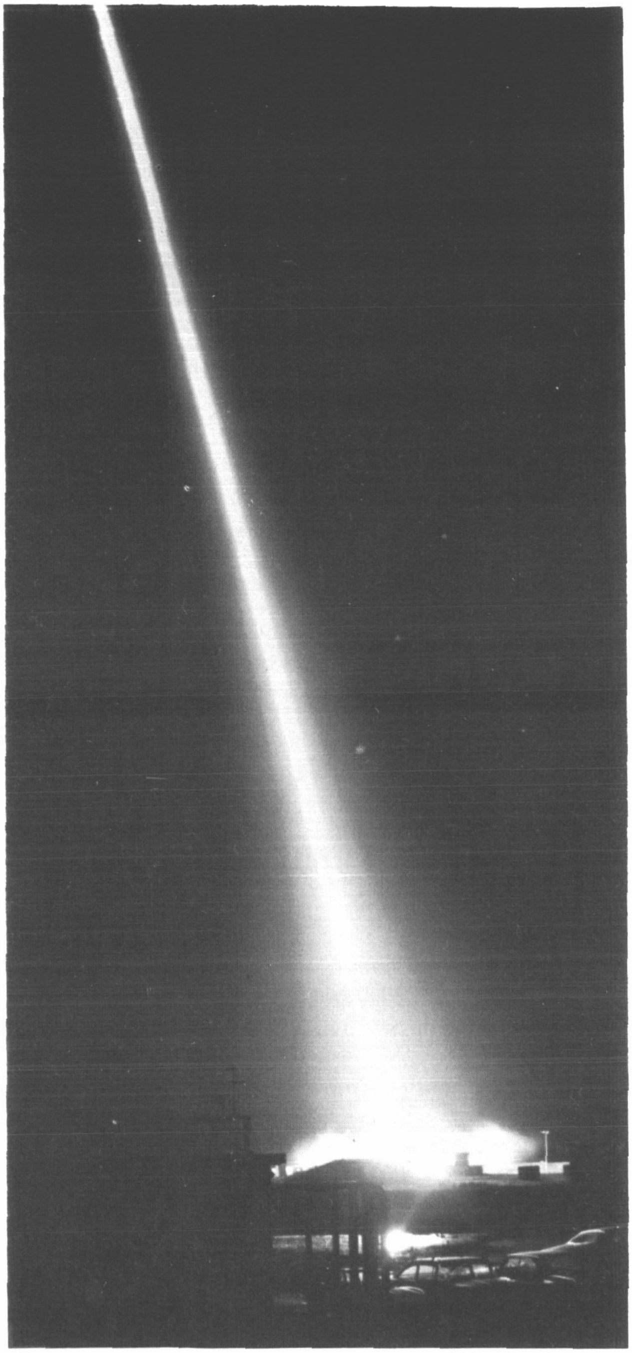
The Goddard computers were to drive the necessary displays and provide the required trajectory information to the NST team to assist them in accomplishing their tasks. Goddard was also to transmit Unified S-Band antenna acquisition data to the USB network in realtime.

SEPTEMBER 29

Alouette I was four years old and still functioned well. Over 6300 miles of actual data has been recorded on tape. In ionograms this represented approximately: 8 million–good; 4 million–fair; 1.3 million–poor.

Three failures to date were:

1. 1 year–one of six energetic particle detectors, a silicon junction device, stopped providing useful data due to degradation from radiation.
2. 2 years plus–five channels of sub-commutated housekeeping data were lost during minimum percent sun. During warmer periods, it still works today. Radiation damage to a mid-frequency transistor is believed to be the cause of failure. Incidently, housekeeping data were obtained on a redundant system.



Lift-off of the Javelin Vehicle from Wallops Island, Va., September 24, 1966.

3. 3 years-11 months–a ni-cad battery pack failed. One of two spare banks was switched in for continued operations.

To date over 150 technical papers have been published on Alouette I data. Large quantities of data have been deposited in the World Data Center, Boulder, Colorado.

Six countries were operating T/M stations and acquiring data: United States, Canada, England, France, Norway and Japan.

Major factors contributing to the longevity of Alouette I are:

Luck (Canadian comment)

National prestige – Canada was the first country other than the U.S. or U.S.S.R. to entirely design and build a satellite. The engineering team assembled was highly talented and technically competent. A very high percentage of these people were Ph.D's who worked full time on the project for over three years.

Redundancy – originally designated for a Delta vehicle, Alouette I was switched to an Agena early in the program which permitted a considerable increase in allowable weight. This was utilized not only for redundant sub-systems but redundancy within circuits as well. The goal was to design every circuit, such that any component could fail without knocking the sub-system out. Through design and extensive design review, this was often achieved. In fact, several components in Alouette I may have failed but cannot be detected.

Testing – all sub-systems were tested and required to function from $-50^{\circ}C$ to $+75^{\circ}C$ (specifications were often relaxed at temperature extremes to avoid use of temperature compensating circuits). Several marginal designs were discovered due to this requirement.

EARLY OCTOBER

A series of Nike-Cajun sounding rockets bearing acoustic grenade payloads were launched from Natal, Brazil and Wallops Island, Va., completing an international series of experiments for meteorological research in the upper atmosphere.

The launchings were carried out under an agreement concluded in 1965 by the Brazilian Space Commission (CNAE) and the National Aeronautics and Space Administration.

Purpose of the experiments was to study variations through the day in winds, temperatures, densities and pressures at 20 to 60 miles above the Earth in equatorial and middle latitudes.

OCTOBER 2

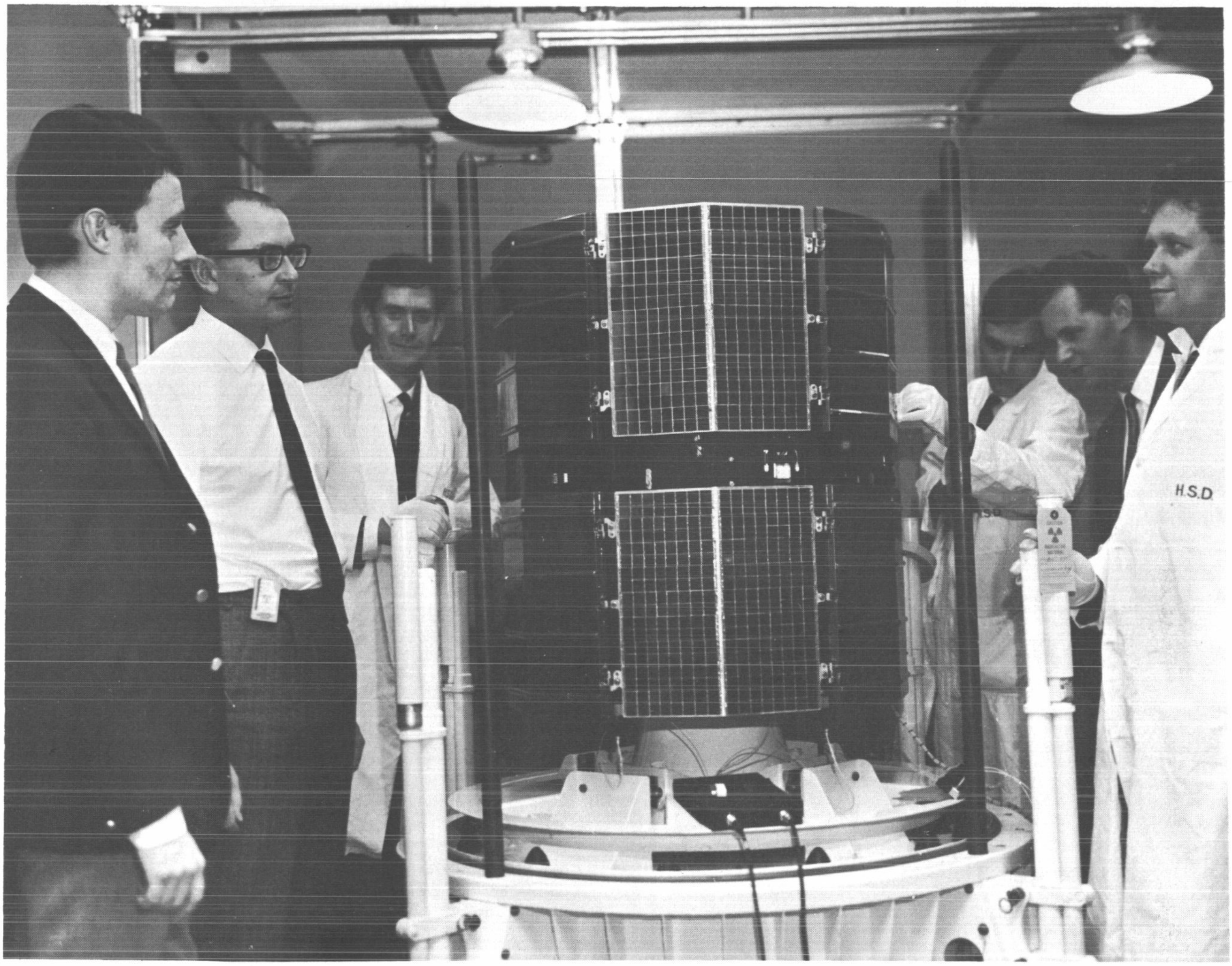
Delta 41 launched ESSA III (TOS-A) at 0339 PDT. Orbital parameters were as follows: Apogee: 802 n.m.; Perigee: 746 n.m.; Inclination: 101.019; Eccentricity: .00650; and Period: 114.54 minutes.

The first pictures received on orbit 127 were excellent, and were being reproduced on a regular daily basis.

ESSA-2 continued to operate well.

TOS-B

This back-up to ESSA-2 was in storage, awaiting call-up by ESSA.



ESRO scientists inspect the ESRO II satellite as it was set up for tests at the Network Test and Training Facility. From left are Daniel Rouat of the ESRO Space Technology Center (ESTEC) in Noordwijk, Holland; Hans Panitz, (ESTEC), Peter Conchie of Hawker Siddeley Dynamics (HSD), in England; Allan Bentley (HSD); Wolfgang Nellessen, (ESTEC); and Gerard Mersch, (ESTEC).

OCTOBER 11

It was disclosed that two unmanned American satellites collided in space while orbiting at five miles a second but withstood the impact and are still in orbit.

Dr. Hilliard W. Paige, a vice president of General Electric Co., told the 17th International Astronautical Congress Meeting in Madrid, Spain, of the first known collision of two satellites. It occurred in April 1965, he said.

Scientists among the 1,200 delegates from 30 countries attending the Madrid meeting said it would be almost impossible to put two satellites purposely into orbits that would cause them to collide.

An American delegate noted that despite speeds of more than 17,000 miles an hour the collision "was probably not stronger than the bumping of a car against the back of another car slowing down at a traffic light."

Paige said the two satellites were launched March 9, 1965, by the U.S. Naval Research Laboratory from a single booster. "Almost two months later," he said, "these two satellites drifted together and collided in what is probably the first man-made collision in space.

OCTOBER 11

The Apollo instrumentation tracking ship VANGUARD, was completed at the General Dynamics shipyards, Quincy, Mass. U.S. Navy representatives turned the tracking ship over to the USAF which will operate it as part of the Atlantic Missile Range.

OCTOBER 12

The Apollo tracking ship VANGUARD sailed from Quincy for Cape Kennedy at 7:00 a.m.

This midnight photograph was taken from a 700-mile altitude by the High Resolution Infrared Radiometer aboard Nimbus II. This picture is one of the most impressive taken since the record-breaking weather satellite was launched on May 15, 1966. The photo (from top to bottom) shows clouds over Canada, Lake Nipigon (above Lake Superior) in Ontario, the Great Lakes, Lake Winnebago and Green Bay in Wisconsin, Lake St. Clair in Michigan, Chesapeake and Delaware Bays, Florida and most of the Gulf of Mexico.

OCTOBER 14

The ESSA III weather satellite became operational and was turned over to the Weather Bureau by NASA/GSFC.

OCTOBER 15

Spain launched her first rocket as the beginning of a long-range weather satellite program.

It was a modest first step into the space field. Spanish officials considered primarily a test of their new launching facilities near Huelva on the Atlantic coast, about 300 miles southwest of Madrid.

The rocket, called Carabela 4, was only 9 feet long, 4 inches in diameter and weighed 88 pounds. It carried a 12-pound instrument payload to an altitude of 40 to 50 miles, then plunged into the Atlantic 40 miles off the coast.

The launching occurred at 11:56 a.m. Spanish time. It was declared a success.

Two officials of the NASA watched the launching: William Hausmann, Deputy of the Director of International Programs, and Clotaire Wood, the NASA representative in Paris.

But the operation was strictly Spanish. The director of operations was Dr. Alvaro Azcarraga, who was assisted by nine Spanish aeronautical engineers and a meteorologist.

The rocket built up a speed of more than 6,000 feet a second on its short flight.

Besides her new launching facility at Huelva, Spain operates jointly with the United States two space tracking stations – one near Madrid, for tracking American deep-space probes, the other in the Canary Islands, for earth orbital missions.

MID OCTOBER

Canton Island voice communications were closed down for twelve hours on October 18-19 to establish voice communications from Hawaii to Pago Pago for President Lyndon B. Johnson during his visit to the American Samoas. The transmitter at Hawaii, which is normally used to provide voice communications with Canton, was used to work with Pago Pago. Teletype communications to Canton were uninterrupted.

OCTOBER 17

A South American earthquake had little effect on communications. The Lima Station Director reported that one of the 10 kw transmitters was shifted a few inches from its base location, however the transmitter remained operative.

OCTOBER 22

Toowoomba, Australia, transportable tracking station for ATS was officially dedicated on October 22 by the Australian Minister for Civil Aviation.

LATE OCTOBER

The Apollo tracking ship, VANGUARD, was undergoing modified Category III tests at Port Canaveral in preparation for AS-204.

LATE OCTOBER

A new voice/data switchboard at the Madrid Switching Center was operational. The data and Teletype technical control facilities was expected to be operational by November 1.

LATE OCTOBER
The Intelsat II (F-1) using Delta 42 was launched at 7:05 p.m. (EST) on October 26. Transfer orbit elements were as follows:

	Predicted	*Actual*
Apogee (n.m.)	20165	20398
Perigee (n.m.)	171.1	175.5
Inclination (deg.)	26.7	26.4
Period (min.)	663.9	672

LATE OCTOBER
The North Carolina tracking station (ROSMAN) was modified for support of Intelsat II launch and was tested in this configuration.

LATE OCTOBER
Through Nimbus II orbit 2192, the following accumulations of data had been received:

HRIR	1407 hours
APT	1753 hours, 56 minutes
DRIR	1202 hours, 54 minutes

OCTOBER 30
The apogee kick motor on the Intelsat II F-1 (Delta 42) spacecraft was fired on command by Comsat at the 9th apogee. There was only partial burn of the kick motor and therefore synchronous velocity was not achieved.

OCTOBER 30
The Apollo tracking ship HUNTSVILLE was accepted from a marine standpoint by the Navy.

NOVEMBER 3
Goddard Building 23 was occupied with the Office of the Assistant Director, Tracking and Data Systems.

NOVEMBER 6
The GSFC Data Operations Branch provided computing support for Lunar Orbiter II. Liftoff occurred at 23:21:00 GMT. The launch was nominal and first and second Agena burns appeared nominal. Acquisition data reflecting the burns was sent to Kano, Tananarive and Carnarvon.

NOVEMBER 8
Using the NASA Communications Network, a mid-course command sequence for Lunar Orbiter II was attempted from Madrid at 1256Z, however loss of Canopus lock forced a delay until 1930Z, when the mid-course was successfully commanded from Goldstone, California, tracking station. Picture taking was expected to begin November 18. Communications have remained good throughout the midcourse and cruise phases of Lunar Orbiter.

NOVEMBER 15
At 4:31 a.m. and with orbit 2449, Nimbus II completed six months of successful operation and met its final life design objective.

At orbit 2455, the HRIR tape recorded failed in record and has not been usable since. This marked the fourth tape recorder in the mission and reduces the spacecraft sensory capability to real time AVCS and APT.

NOVEMBER 15
Lunar Orbiter B remained nominal throughout the mission. The second deboost maneuver was accomplished at approximately 2100Z with no problems encountered. Lunar Orbiter was down to within 28-30 miles of the moon. Communications were good throughout the mission.

NOVEMBER 15
The Nimbus II weather satellite completed six months in orbit. Launched May 15, 1966, Nimbus II has operated as planned and longer than any other large earth-orbiting observatory type satellite. Two tape recorder failures had not prevented Nimbus from photographing the world every day and again at night.

The satellite's one daytime camera, which sends "live" pictures to APT ground stations around the world, and an infrared sensor for nighttime photography continued to provide excellent pictures of the world's weather. To date this satellite had produced over 860,000 useful weather photographs.

Nimbus II accomplishments included:

Photographed 17 typhoons and 9 hurricanes; Photographed the entire world twice every day (day and night); Photographed the meandering course of the Gulf Stream; Sent "live" pictures to ground stations in more than 30 countries; Operated 24 hours a day for six months; traveled 72,000,600 miles; and Orbited the world 2,449 times.

NOVEMBER 15
With GT-12 the Gemini program was completed. Looking back over the program, 12 missions were flown since April 8, 1964 when GT-1 was launched on the new TITAN II booster. In retrospect the GSFC technical staff was pleased to observe (J. J. Donegan) how well the Manned Flight Network performed considering the new PCM telemetry equipment, the new Digital Command equipment, the On-Site Data Processing equipment and the operational procedures to accommodate multiple vehicles on the network, inflight maneuvers and lifting reentry. Goddard designed and implemented the network and managed its operation.

Since the summer of 1966 GSFC started supporting Gemini and Apollo missions simultaneously, and the pace was frantic.

NOVEMBER 18
With conclusion of the Gemini program, (GT-12 concluded Nov. 15, 1966) the United States notified the Government of Nigeria that it was closing its tracking station at Kano.

THE MIAMI HERALD Sunday, Nov. 6, 1966

'For future generations of American children, name association with great scientific accomplishment will include: the electric light — Thomas Edison; the airplane — the Wright brothers; and rockets — Robert H. Goddard.'

—Mrs. Robert H. Goddard

HER HUSBAND Father of the Space Age

ON MARCH 16, 1926, at Auburn, Mass., a scholarly physicist, Dr. Robert H. Goddard, successfully fired a liquid-fueled rocket, the forerunner of today's missiles. This is part of his story, as told by his wife, who is dedicated to securing her late husband's position in history as the Father of the Space Age.

By MRS. ROBERT GODDARD
World Book Encyclopedia Service, Inc.

WORCESTER, Mass. — When I married Bob Goddard in 1924, I was 19 years younger than he and had no inkling that he would be the father of the Space Age or that I would live to see Americans riding to the moon boosted by rockets which my husband first developed.

It wasn't until after his death in 1945 that I began to understand his scientific theories and rocket designs for space travel. Mathematics was not one of my best subjects in school. He was a genius in physics; I was a history-English major.

Nevertheless, Bob's death meant that I had to complete details that he left unfinished, details that seemed secondary to the masterminding of rockets while he was alive — but which eventually guaranteed his position in history as the father of the Space Age.

I read all that Bob had written, studied his drawings and photographs for the patent attorney. Only after extensive study did I finally gain the knowledge of rocketry that I have today. I had no technical knowledge at all, but little by little, I learned.

Every bit of my husband's work, from the day he started until his death, is in written, drawn or picture form — and all of it will be placed in a library being built in his honor at Clark University, Worcester, Mass., scheduled to open in 1968.

30 Years Of Experiments

DURING World War I, my husband designed efficient solid propellants which later were the foundation of the World War II bazooka. Thereafter he perfected much more powerful liquid propellants to launch rockets into space.

So thorough were the results of his experiments over more than 30 years that today there is hardly a phase of the space program that does not touch upon the work he did.

If Bob could have witnessed the huge space programs to today, he would be happy for the vindication of his ideas and dreams that aroused skepticism in the 1920's.

He would have enjoyed comparing today's astronauts with the eager young pilots who visited our home and shop back in the late 30's. They

THE MIAMI HERALD

not nearly as impressive as the great manned space flights of today.

Prior to the 1926 experiment, Bob used solid fuels for his rockets. For this one he used a liquid oxygen combination. It did the trick. The liquid fuels lifted the rocket out of its frame for the first time, anywhere. Bob knew then he had discovered the energy to conquer space.

But it was difficult to get the precious liquid. At first he was able to procure some from the Massachusetts Institute of Technology, bringing it back to Worcester in a couple of thermos flasks.

Research Dollar Went Long Way

NO ONE knew exactly what to do with liquid oxygen in those days. It took Bob to realize that it was the ingredient that would bring the space rocket era into being.

Thinking back, it is truly amazing how much Bob did with modest funds. He was a real New England Yankee and could get more out of a research dollar than anyone.

Our life together, whether it was in Worcester while he taught at Clark University or at Roswell, New Mexico, or during the last years of Annapolis, always had New England overtones. We were disciplined in everything we did. Even Sundays included a long work day, beginning with a real old fashioned Yankee steak breakfast. Afterwards we worked together answering the week's accumulation of mail.

He had a Yankee sense of humor too. Before we went to New Mexico, Bob had been conducting some experiments at a place called Hell Pond at Fort Devens, Ayer, Massachusetts. In New Mexico, our launch site was located in Eden Valley.

Whenever things seemed to look bad he would tell me we had moved from Hell to Eden so the future had to be rosy.

Actually things got worse for a while and Bob hit the low point of his life in 1932 when, because of the depression, the Guggenheim Foundation was forced to cancel his research grant for a couple of years.

Mrs. Robert H. Goddard Holds Drawing
. . . it depicts her husband's initial rocket launchings

We had been doing so well in New Mexico and to suddenly have to stop was a great blow to Bob.

Clark University came to our rescue. It had kept his teaching post open for him, and we came back to Worcester where Bob continued to pore over the work already done, trying to improve some of the devices that the New Mexico tests had indicated needed improvement.

In 1934 the Daniel and Florence Guggenheim Foundation resumed its generous support and made possible the "golden years" from 1934 to 1941 when my husband undertook war work for the Navy.

Life Always Exciting

BOB WAS a warm, very human, kind and loving individual who inspired respect in everyone he met, and even love in those who knew him well. My life with him was always exciting even during the hard times of the depression and it gives me more joy than I can say to know that I was helpful to him even in a small way.

It has been wonderful to be a part of the space drama as it has unfolded.

Only in the past few years have Bob's accomplishments begun to take their rightful place in the history of the world. Many honors have been bestowed upon him posthumously, and I have received scores of requests for literature and photographs to be included in articles and books and most recently in school text books.

This last chore has made me happier than anything else. It means that some day when children in classrooms throughout the country are asked whom they associate with works that have meant great progress to civilization, they will include my husband.

For future generations of American children, name association with great scientific accomplishment will include: the electric light — Thomas Edison, the airplane — the Wright Brothers, and rockets — Robert H. Goddard.

IN THE NAME AND BY AUTHORITY OF THE

COMMONWEALTH OF PENNSYLVANIA
GOVERNOR'S OFFICE
HARRISBURG

PROCLAMATION

NIMBUS II DAY - NOVEMBER 15, 1966

WHEREAS, November 15, 1966 marks six-months-in-space for NIMBUS II, the largest weather satellite ever launched; and

WHEREAS, The satellite was built by the Missile and Space Division of the General Electric Company in Valley Forge, Pennsylvania, for the Goddard Space Flight Center of NASA (National Aeronautics and Space Administration); and

WHEREAS, General Electric's Missile and Space Division built the satellite's structure and integrated the work of more than thirty Delaware Valley firms; and

WHEREAS, Recognition should be given the contribution made by NIMBUS II toward the advancement of man's knowledge of the weather. It should also hail the contributions of thousands of Pennsylvanians who helped to build the satellite for NASA'S Goddard Space Flight Center; and

WHEREAS, All Pennsylvanians can take pride in the amazing accomplishments of this very complex meteorological satellite which by November 15th will have flown 72-million-600 miles, and will have orbited the earth 2,449 times and will have taken 860-thousand photographs; and

WHEREAS, In light of the excitement and meaning behind our man-in-space programs, it is easy to lose sight of the true significance of our unmanned projects;

NOW, THEREFORE, I, William W. Scranton, Governor of the Commonwealth of Pennsylvania, do hereby proclaim November 15, 1966 as NIMBUS II DAY in Pennsylvania, and call upon our citizens to recognize with pride the vital role played by unmanned spacecraft such as NIMBUS II as an essential part of the space program.

GIVEN under my hand and the Great Seal of the State, at the City of Harrisburg, this tenth day of November, in the year of our Lord one thousand nine hundred and sixty-six, and of the Commonwealth the one hundred and ninety-first.

William W. Scranton
WILLIAM W. SCRANTON
GOVERNOR

BY THE GOVERNOR:

Secretary of the Commonwealth

Station technicians and their families were to be returned to the United States or to other foreign assignments by the Bendix Field Engineering Corporation, Owing Mills, Maryland, NASA contractor for operation in maintenance of stations in the Manned Space Flight Network.

The Kano station was established under a United States-Nigerian agreement of October 19, 1960, for support of Project Mercury, it was subsequently used for the Gemini program. With the reconfiguration of the tracking network for Project Apollo, the Kano station was no longer needed.

In the message notifying the Federal Military Government of Nigeria of the termination of the tracking station, the United States Ambassador said, "The Government of the United States of America expresses its deep appreciation for the cooperation which Nigeria has demonstrated in making a station possible on Nigerian territory.

"The Government of the United States of America is also grateful for the cooperation which the Government of Nigeria extended to the SYNCOM Experimental Communications Satellite project and the cooperation of the Government of Nigeria in permitting the staging at Kano of astronaut recovery aircraft.

NOVEMBER 18

The launch platform for San Marco B was placed into position and erected in Formosa Bay.

NOVEMBER 18

The Kano, Nigeria tracking station permanently closed at 1530z. Equipment and personnel withdrawal was expected to be complete by mid-December 1966. All STADAN equipment and antennas were to be returned to the U.S.

MID NOVEMBER

The FR-1 satellite completed 357 days of successful operation. Presentation of Scientific Data from this satellite was to take place at GSFC on January 23 and 24, 1967. The data was to be presented by the French Project Scientist, Dr. L. R. O. Storey and his team.

NOVEMBER 22

The AIMP-E ETU spacecraft, equipped with a prototype attitude control system and fourth stage attach fitting, plus engineering models of the new nutation dampers, contamination monitor, and Temple sensor plate, was subjected to launch phase acceleration. The spacecraft survived the launch phase acceleration level 29 g's (36.5 rpm) successfully. No problems with the new spacecraft hardware were encountered.

NOVEMBER 25

Goddard management assigned a top priority to the OAO Recovery Plan second only to Apollo. Expeditious and economical execution of this plan was considered to be of extreme importance to the Center.

NOVEMBER 25

Explorer 32 completed six months of operation. The mission had exceeded generally expectations regarding the data obtained, and operation of the satellite.

NOVEMBER 27

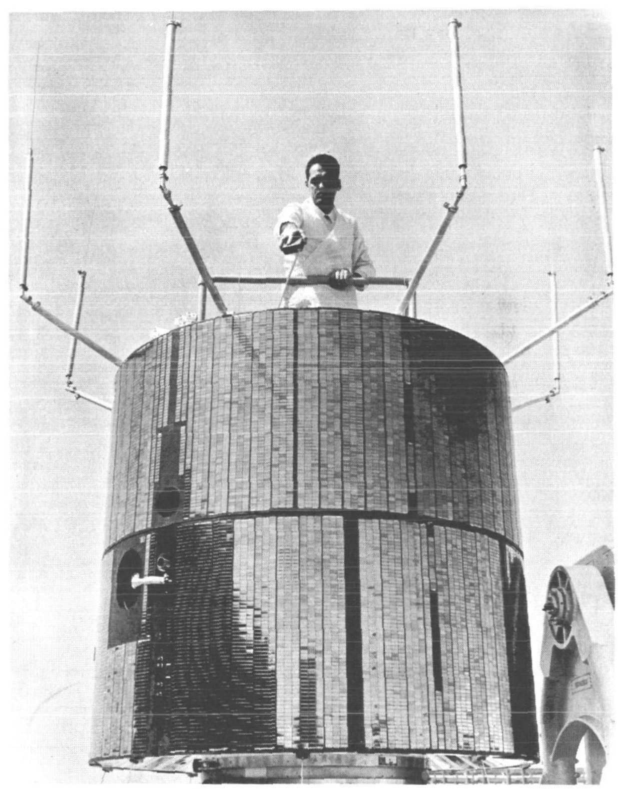
The ATS-B spacecraft continued on schedule. The spacecraft and shroud combination was attached to the Agena.

NOVEMBER 28

NASA 428 departed Friendship Airport, Baltimore, Md. for Fairbanks, Alaska for acceptance tests of the 40-foot antenna, calibrations of Minitrack and S-Band Range and Range Rate, and routine command and telemetry tests.

NOVEMBER 30

WWV, the National Bureau of Standards, "time" station, located near Goddard, discontinued broadcasting. The operations were moved to Colorado.



Technician inspects the Applications Technology Satellite-B (ATS-B). Shown at the top are eight Very High Frequency (VHF) antennas. These antennas make up part of the VHF communications experiment carried aboard the spacecraft to conduct tests in relaying communications between ground stations and inflight aircraft. The spacecraft periphery is covered with 22,000 solar cells which provide power for operating the spacecraft and recharging its batteries.

NOVEMBER 30

Biosatellite A spacecraft mating on stand with Delta 43 was accomplished without incident.

LATE NOVEMBER

Despite a highly eliptical orbit the Intelsat II spacecraft was performing well. Various TV demonstrations were conducted to and from Hawaii, Japan, and the U.S. mainland.

LATE NOVEMBER

Typical Stadan support:

NOVEMBER 30

Dr. Norman F. Ness of GSFC reported that experiment results from Explorer XXXIII have shown for the first time that the tail of the earth's magnetosphere extends beyond the orbit of the moon to at least 316,000 miles from earth.

In a paper presented to the 3rd Annual meeting of the American Institute of Aeronautics and Astronautics in Boston, Dr. Ness said that it was clearly established from magnetic field studies conducted by Explorer XXXIII that the magnetosphere tail "extends more than 75,000 miles beyond the orbit of the moon." *Just how* far was still unknown.

Spacecraft Name	*TLM Passes Supported*	*Mins Data Recorded*	*Passes Supported*	*M/T Messages*	*R & RR Messages*	*X-Y Messages*	*Optical Messages*
ALOUETTE-1	43	401	20	18			
TIROS-7	20	222	10	10			
SN/39	40	588					
TIROS-8	1	12	15	15			
RELAY-2	44	1,438	58	57			
ECHO-2			38				21
OGO-1	12	1,572	57	6	5	39	
BE-B	97	1,524	63	62			
AIR DENSITY			95	90			
EPE-D	61	9,915	39	38			
TIROS-9			56	48			
OSO-2	NO SCHEDULED OPERATIONS						
PEGASUS-A	7	77	42	41			
EGRS-3			36	35			
BE-C	32	556	41	37			
PEGASUS-B	16	207	37	37			
IMP-3	23	11,277	40	3	35		
TIROS-10	3	28	33	30			
PEGASUS-C	7	83	56	56			
OGO-2	158	1,732	97	66	21		
GEOS-1	29	738	424	213	35	9	51
IQSY	101	1,378	71	70			
ALOUETTE-2	83	1,308	35	34			
DME-A	95	412	26	24			
FR-1	60	668	55	52			
ESSA-1			50	34			
ESSA-2			117	93			
NIMBUS-2	300	4,555	99	95			
AE-B	169	712	35	33			
OGO-3	32	2,960	106	18	3	77	
EGRS-6			45	42			
ORS-2	3	35	22	18			
PAGEOS-A			117				25
IMP-D	20	11,277	28	10	14		
EGRS-7			119	112			
ERS-15	2	86	129	128			
ESSA-3			255	186			

American and French FR-1 launch teams with the satellite on its Scout rocket at the launch pad just prior to erection, Dec. 6, 1966. On the catwalk to the left (dark suit) is Samuel R. Stevens, Goddard FR-1 project manager, with project coordinator Joseph H. Conn directly behind him. Opposite on the other catwalk is J. P. Causse, Director of CNES's laboratory at Brittany, France, and behind him is Xavier Namy, CNES FR-1 project manager.

EARLY DECEMBER

The GSFC selected the General Electric Co., Missile and Space Division in Valley Forge, Pa., for contract negotiations for the Nimbus D weather observatory.

The contract was expected to total about $10 million dollars. Under the contract terms, G.E. will be required to integrate, test and fabricate the Nimbus spacecraft.

G.E. has already integrated and tested Nimbus I and II and is currently working on the third Nimbus.

General Electric will also be required to integrate and test other GFP, the Thor Agena adapter and meteorological sensors.

Nimbus D is scheduled for launching in early 1970.

DECEMBER 1

Reconfiguration of the range timing system from Gemini configuration to Apollo was in progress. The Bermuda FPQ-6 became fully operational.

DECEMBER 1

The College, Alaska, STADAN station ceased operations.

EARLY DECEMBER

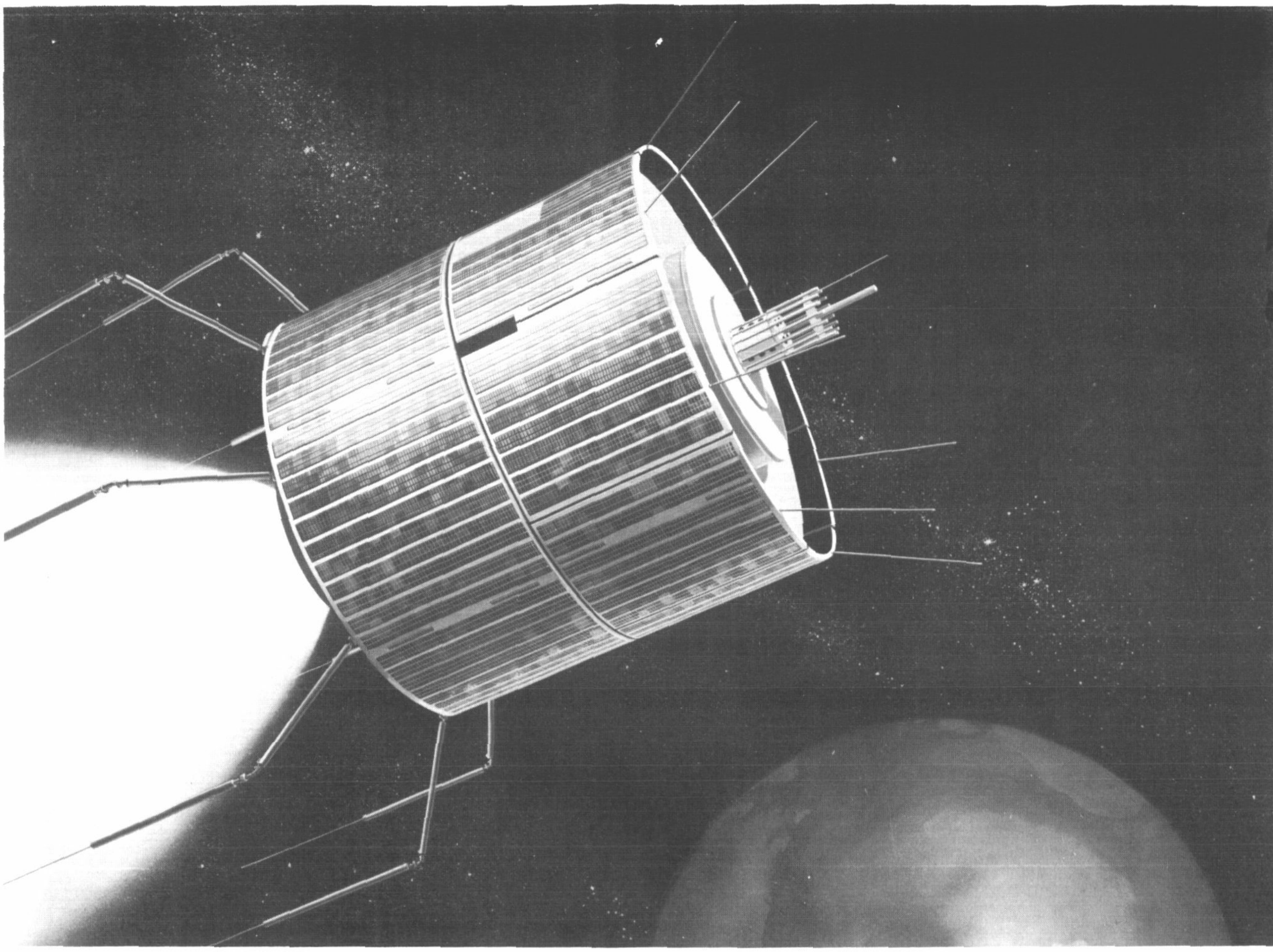
Apogee of Intelsat II (F-1) was occurring at about 1930 Z with about 7 hours mutual visibility between Hawaii and Washington. This provided circuits at prime telephone time. About 25 circuits are in use at this time.

DECEMBER 4

The Madagascar station participated in the centennial celebration of Malagasy. The station had open house and a picnic with total visitors between one and two thousand. The station was also visited by Assistant Secretary of State Palmer, Malagasy Minister Ravoahangy, four ambassadors, and over one hundred government officials and representatives of local enterprises.

DECEMBER 5-7

The ATS-B/satellite was launched from the Eastern Test Range at 9:12 p.m. EST. Preflight nominal values for the principal elements of the transfer orbit and



Artist's sketch of ATS-1 launched December 6, 1966.

values for these elements obtained from an orbit determined on the basis of Minitrack and range and range rate data were as follows:

	Preflight Nominal Values	Values Based on Early Minitrack and Range and Range Rate Data
Period (min.)	648	650
Perigee height (st. miles)	115	114
Apogee height (st. miles)	22,790	22,862
Inclination (deg.)	31	31

Range and range rate observations from the ATS station at Toowoomba, Australia, Kashima and Rosman were used in the determination of this orbit.

The apogee motor was fired at 1:46:19 p.m., December 7th. Values for the principal elements of the resulting orbit obtained on the basis of range and range rate data were as follows:

	Values Based on Early Range and Range Rate Data
Period (min.)	1,466
Perigee height (st. miles)	22,277
Apogee height (st. miles)	22,921
Inclination (deg.)	0.24

DECEMBER 6

Results of a broad review of the observatory-class earth satellites were announced. The review which began on April 21, 1966 was made by a five-man board which studied the failure of the Orbiting Astronomical Observatory I and reviewed observatory project practices used by NASA.

In addition to OAO, the board reviewed the Orbiting Solar Observatory, Orbiting Geophysical Observatory, and Nimbus meteorological satellite project practices.

The Board, appointed by Dr. Homer E. Newell, Associate Administrator for Space Science, was chaired by Newell's Deputy for Engineering, Robert F. Garbarini.

DECEMBER 7

The Apollo instrumentation ship "VANGUARD" left Port Canaveral to begin Category III and Apollo Mission Readiness Testing. "REDSTONE" sea trials were also held.

DECEMBER 8

NASA and the Brazilian Space Commission (CNAE) announced an agreement to conduct important X-ray astronomy studies of segments of the Southern Hemisphere sky by launching a 225-pound payload on an Aerobee 150 sounding rocket from a mobile launch facility at Natal, Brazil.

DECEMBER 8

A major reorientation of the attitude of the Applications Technology Satellite I was conducted at about 3:30 p.m. EST. The ATS-I orbit was also changed as a result of this maneuver. The principal elements of the resulting orbit was determined on the basis of range, range rate and x-y angular tracking data. The orbit was also modified as a result of a number of additional orbit and attitude control maneuvers which were conducted earlier.

Epoch (day, hr, min, UT)	082030	091815	122300
Period (min.)	1478.7	1478.6	1475.5
Perigee height (st.m.)	22488	22487	22455
Apogee height (st.m.)	23016	23015	22971
Inclination (deg.)	0.36	0.38	0.37

Epoch (day, hr, min, UT)	130346	141827	150742
Period (min.)	1458.4	1454.6	1446.6
Perigee height (st.m.)	22410	22323	22321
Apogee height (st.m.)	22604	22601	22409
Inclination (deg.)	0.36	0.37	0.35

DECEMBER 9

The following appointments were made within the Laboratory for Atmospheric and Biological Sciences:

Mr. Harry A. Taylor, Jr., Acting Head of the Aeronomy Branch, was designated Branch Head; Mr. Dean S. Smith, Acting Head of the Experiment Engineering Branch, was designated Branch Head.

DECEMBER 13

ATS-1 press conference was held at Goddard. ATS experimenter, Prof. Verner Suomi, University of Wisconsin, presented first evaluation of earth's weather photos received from the satellite. These included sunrise-sunset sequence received December 11. The satellite's color television capability was demonstrated by televising live color action at the Mojave Tracking Station via the ATS satellite to the press conference. Quality was excellent. Also highly successful was the demonstration of a communications experiment linking five in-flight aircraft via the ATS satellite with a ground station communicator at Goddard.

DECEMBER 13

A press conference for the ATS project was conducted at Goddard. Star of the show was ATS 1, the "applications technology satellite" launched into a high equatorial orbit December 6, 1966.

While newsmen and space officials watched, ATS relayed high-quality color television, linked ground controllers with air-borne jet planes as far away as the Aleutians, and sent back to earth a picture of the world's weather that plainly showed the eastern seaboard storm which was blanketing Washington with snow at that moment.

The satellite, a 700-pound package lived up to its "advanced technology" billing is the first of five such satellites set for launching between 1966 and 1970.

At the briefing ATS 1 was hailed as opening a new era in the use of spacecraft. Leonard Jaffe said ATS 1 "represents an order-of-magnitude increase over the Syncom satellites launched beginning three years ago."

Even before the pre-briefing some 34 pictures were on display made of the earth in the course of one day, Dec. 11. They showed in order sunrise, early morning, late forenoon, high noon, early and late afternoon and sunset.

From ATS's altitude of 22,300 miles, the earth looked like a big moon going through its phases. Outlines of the North and South American continents were clearly visible, and in the course of the day, changing cloud formations over the Pacific made intriguing patterns.

ATS went through three demonstrations:

It received and retransmitted live and in color a briefing held at Goldstone Dry Lake, Calif.

It handled voice conversations between a ground station here and airplane in flight over the United States, over the Pacific near San Francisco and over the North Pacific over Shemya Island in the Aleutian chain. This was an early experiment in a series designed to improve air-ground communication and, consequently, air safety in the jet age.

It transmitted a picture of the earth while all this other activity was going on. This picture was received at a ground station at Rosman, North Carolina and transmitted to Goddard by overland circuits where it was captured on Polaroid film and quickly made available for viewing at the briefing.

Officials were elated by ATS's performance, perhaps their frame of mind was best summed up by Prof. Verner Suomi of the University of Wisconsin. Suomi, a meteorologist, is the chief experimenter on the world-weather pictures.

"It's a roaring success, with performance beyond my wildest dreams," Suomi said.

DECEMBER 14

At 2:20 p.m. EST, Biosatellite A was launched into a three day orbit. This was the first launch of a two stage Delta (Delta 43) and overall mission support necessitated, by far, the most extensive mission peculiar equipment to date. The countdown was completed without incident and the trajectory was nominal. Basic orbit elements were as follows:

	Desired	*Achieved*
Apogee (n.m.)	170	171.2
Perigee (n.m.)	170	166.0
Inclination (deg.)	33.50	33.53
Period (min.)	90.76	90.76

DECEMBER 15

It was announced that a contract would be negotiated with the Douglas Aircraft Co., Santa Monica, Calif., for 14 upper stages for the Delta launch vehicle.

The fixed price incentive contract was expected to total about $15 million.

The procurement was for 14 improved second stages—larger in diameter than the original Delta stages. These will include the first improved second stages modified to be mated to longer Thor first stages which NASA was planning to use on the Delta configuration beginning in 1968.

To date, NASA launched 43 Delta vehicles and achieved 40 successful flights. Delta's have launched weather, communications and scientific earth satellites and pioneer deep-space probes.

Work on the new contract was performed at the Douglas Missile and Space Systems Division, Santa Monica.

THE SUNDAY STAR
Washington, D. C., January 8, 1967

BELTWAY 'ASTRONAUTS'

The Earthbound Space Explorers

By WILLIAM HINES
Star Staff Writer

The "astronauts" who work at Goddard have never been fitted for space suits, but they have racked up quite a creditable record for exploring some out-of-the-way parts of the solar system.

Goddard is the National Aeronautics and Space Administration's Goddard Space Flight Center near Greenbelt, just beyond the Beltway and just east of the Baltimore-Washington Parkway. Nearly 6,000 metropolitan Washingtonians—two thirds of them civil servants—work there on some of the most far-out projects ever undertaken.

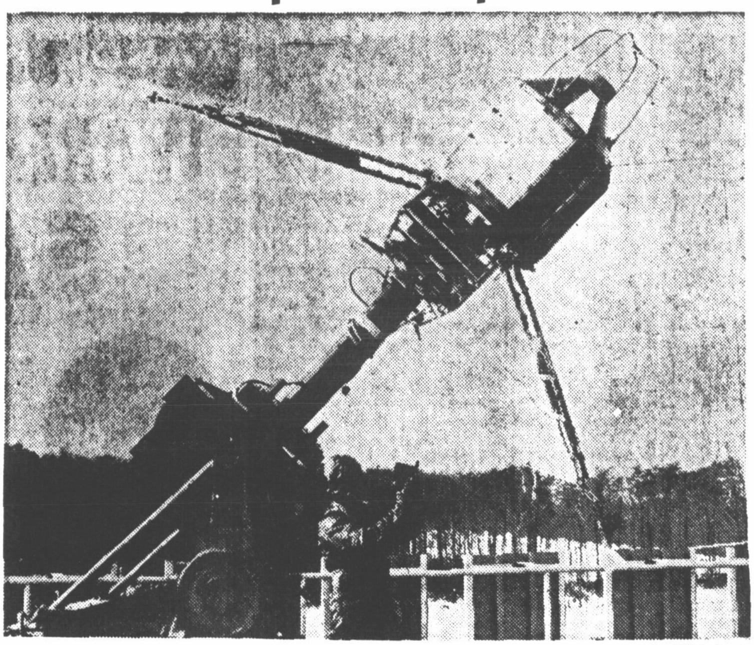
Last year, for example, spacecraft from Goddard sent back to earth more than one million pictures of the world's weather—some from nearly 25,000 miles out in space—and at year's end eight of nine craft launched during the year were still operating.

Practice Futuristic Trade

In Goddard's shops, control rooms and computer centers white-smocked and shirt-sleeved scientists and technicians quietly practice the futuristic trade of astronautics. Though they get less publicity than "genuine" astronauts like Gus Grissom and Wally Schirra, their work is no less essential to the nation's space program.

Goddard's all-time record for spacecraft launchings is .922—47 successes out of 51 tries. Two of the four "failures," oddly enough, produced valuable data, space scientists say.

Scientists from Goddard are now preparing for launching one



—NASA Photo

On the quiet side of the nation's space program, scientists and technicians are working at Goddard Space Flight Center on some of the most far-out projects ever undertaken. Above, a technician tests a British UK-3 spacecraft.

of the oddest-looking spacecraft ever built. When it gets into space this summer, it will unfold tightly packed antennas and transform itself into a veritable daddy-longlegs. Called "RAE" (Radio Astronomy Explorer), the craft with its 1,500-foot "leg-span" will help scientists map [illegible] frequencies

Sounding Rocket Project

A little-publicized continuing activity at Goddard is its "sounding rocket" program, which last year saw 158 high-altitude rockets launched into the upper atmosphere.

In its year-end report, Goddard said 67 of the 158 sounding rockets were launched outside the United States; 80 carried space research experiments, and 13 included experimental gear built by foreign scientists.

The center was named for the late Robert H. Goddard, "father of American rocketry," who did much of his later work not far from Greenbelt, at a Navy installation near Annapolis. Though farsighted, Goddard probably would never have foreseen the scope of his namesake center's work, in terms of either acitivity or money—an estimated $400 million last year.

DECEMBER 15
The ATS-I spacecraft was at approximately 149.4° west longitude at 1:00 p.m. EST on Thursday, December 15, 1966. The westward drift rate was approximately 2.6° per day.

DECEMBER 15
The USNS VANGUARD was at sea undergoing Category III navigation tests.

DECEMBER 18
As a result of a successful reorientation maneuver conducted at 5:00 a.m. OGO-III had an additional 3 to 4 months of full power operation. Array current reached a peak of 7.6 amperes average. Briefly, the reorientation consisted of the following actions:

The spacecraft was despun to nearly zero rotation about its yaw axis and induced to wobble through a carefully prescribed arc in the desired direction of motion. At the correct time, an additional despin pulse was applied which actually reversed the yaw spin motion causing the previous wobble arc to be inverted. This caused the spacecraft to move in a scalloped fashion in the desired direction. The spacecraft was then anchored at the new position by spinning again about the yaw axis. The spacecraft yaw axis was moved from a position at -20° declination and 50° right ascension to a new position at 0° declination and 86° right ascension as planned.

Eugene W. Wasielewski, Goddard Associate Director, cuts the ribbon to officially open the new Network Test and Training Facility. Watching are (from left) John T. Mengel, Assistant Director for Tracking and Data Systems; Ozro M. Covington, Deputy Assistant Director for T&DS; and Edmond C. Buckley, NASA's Associate Administrator for Tracking and Data Acquisition.

DECEMBER 19
TIROS VII completed for 3½ years. Both camera systems were working. Although one camera produced pictures slightly out of focus, the other continued to provide excellent pictures. Both tape recorders of the camera system were functioning normally. The IR subsystem was functioning, although the sensors had degraded. A test of the IR subsystem on December 14, 1966, showed the playback time of the recorder to be normal at 3 minutes, 40 seconds. This recorder had been operating continuously since launch. The spin rate was approximately 3.2 rpm, and decreasing at about .1 rpm.

DECEMBER 21
TIROS VIII completed 3 years in orbit. The attitude control system had failed but recent checks showed that other spacecraft subsystems were still operative. The standard TIROS camera system, including the tape recorder, was capable of providing good pictures, but not like those excellent, earth disc pictures of the scan camera on ATS-1.

DECEMBER 23
The Gemini-Agena 12 reentered the atmosphere at 1243Z ± 30 minutes in the South Pacific Ocean.

DECEMBER 26
An agreement to conduct a series of joint meteorological rocket launchings was concluded between NASA, the Japanese Science and Technology Agency and the Japanese Meteorological Agency.

To start in March 1967, 10 Japanese MT-135 sounding rockets, capable of boosting a 6.6-pound payload to 200,000 feet, and 10 U.S. Arcas or boosted-Dart sounding rockets will be launched from NASA's Wallops (Va.) Station to obtain comparison data on the various payloads and the operational characteristics of the rockets, as well as additional information on the diurnal cycles of wind and temperature in the stratosphere.

DECEMBER 29
The Gemini-Agena 10 reentered the atmosphere at 1859Z ± 10 minutes in the Pacific Ocean.

DECEMBER 30
The Gemini-Agena 11 reentered the atmosphere at 0730Z ± 15 minutes in the Pacific Ocean.

DURING 1966
The Goddard Staff received the following awards:

NASA GROUP ACHIEVEMENT AWARD

The Apollo Staffing Group

For outstanding success in staffing a highly complex research organization; for support of the Apollo Program in the face of a highly competitive labor market.

The ESSA-1 Project Group

For outstanding work in the successful development and operation of the first Tiros Operational Satellite.

The Evening Star

A—10 ★★ THURSDAY, DECEMBER 22, 1966

WASHINGTON CLOSE-UP

When It's Good, It's Very Good

By WILLIAM HINES

Even the severest critic of the National Aeronautics and Space Administration must acknowledge that this big and sometimes brash agency is strikingly like the little girl with the curl. To turn the nursery rhyme around, when NASA is bad it is horrid, but when it is good it is very, very good.

One of its "very, very good" performances occurred at Goddard Space Flight Center near Washington last week, when NASA demonstrated the capabilities of its latest unmanned spacecraft. This was ATS 1, launched Dec. 6, the first of five "applications technology satellites" to be orbited by the middle of 1969.

In the course of about half an hour, ATS was put through a most remarkable set of paces:

1. It relayed a live color television broadcast from California to Goddard and simultaneously to a ground station in Australia.

2. It established a live voice-radio link of excellent clarity between the Goddard center and a commercial jet transport in flight near the Aleutian Islands.

3. Simultaneously, a telescopic camera aboard the craft made and transmitted a photo of the earth from an altitude of 22,300 miles which clearly showed storm clouds that were blanketing the East Coast with snow at the time.

One is hard put to decide which of ATS' three "acts" was the most significant—or the most impressive. All three have tremendous implications for the future as the world continues to shrink and demands for reliable global communications continue to expand.

Probably the most immediate need, still unfilled by satellites, is in the realm of communications between airplanes in flight and their ground-based control stations. Aerial commerce is growing explosively, doubling each 10 years in terms of passengers and cargo tonnage carried. Also, radically new commercial planes including supersonic ones are on the horizon.

Present radio communications between the ground and transoceanic commercial planes are hardly tolerable even today; by tomorrow they will be grossly inadequate.

Fitted with the proper type of antennas, aircraft in flight will be able to keep in constant touch with control centers by means of satellite relay. Better communications will enhance aviation safety and at the same time permit heavier traffic on the air lanes.

Use of a high-altitude satellite as a weather eye, demonstrated for the first time with ATS 1, is an old idea that was resurrected after having been buried for budgetary reasons. At the time the Tiros weatherbird project got its start in 1960, a three-step meteorology program was envisioned. After Tiros would come the polar-orbiting Nimbus, and after that would come Aeros, a super-satellite hanging motionless in the sky, scanning the weather over a third of the globe.

Space technology has come so far since then that the 1966 version of Aeros could be packed piggy-back on a multipurpose satellite rather than requiring one of its own. Also, ATS' weather pictures probably are a little better than Aeros' planners would have thought possible. Cloud formations no more than three or four miles across can be spotted with careful study.

NASA uses the word "applications" to denote those useful things done with inventions and discoveries from the space effort. Communications and weather constitute the principal applications to date—at least in the civilian end of space—and probably will continue to head the list for some time to come.

It is easy to forget how far and how fast these two branches of space technology have moved. Tiros 1 was launched in April 1960; today, less than seven years later, world-wide weather reports from space are routine and a non-space-oriented agency (the former Weather Bureau) is operating a network of meteorological satellites.

Communications is an even newer field but—possibly because of its rich commercial promise—has progressed even further. The first workable relay satellite, Telstar 1 (a private, not a NASA, payload) was orbited only 4½ years ago. Today a special corporation, "Comsat," is busily engaged in international trade—and busily engaged, also, in fending off would-be competitors, which probably tells all that needs saying about the success of space communications.

By all the measures to which the public has become accustomed in the space age, the payoffs through weather and communications satellites have come cheap. Counting Tiros, Nimbus and the Relay and Syncom communications programs, the total NASA-funded cost to date has been $240 million. The ATS series through 1969 will add $150 million to this.

Alongside $400 million for Project Mercury, $1.35 billion for Project Gemini and the $23 billion anticipated for the Apollo manned moon program, these are bargain-basement price tags indeed.

The TIROS Operational System Group

For outstanding technical achievement in the design and direction of an advanced meteorological system involving global weather applications.

Engineering Design Task Team – Test and Evaluation Division

For outstanding achievement in the conception, design and development of the first SES spacecraft positioning facility.

NASA HONORARY AWARD

Outstanding Leadership

Dr. John F. Clark, Director, for outstanding achievement as a scientist and administrator in conceiving and implementing a variety of imaginative and fruitful space science experiments and projects. For effectively directing and coordinating complex research involving diverse disciplines and interests, thereby contributing significantly to the Nation's space effort.

Exceptional Scientific Achievement

Dr. Norman F. Ness, Assistant Head, Fields and Plasmas Branch, Laboratory for Space Sciences, for outstanding scientific achievements in the conduct of interplanetary research which have contributed significantly to the peaceful study and scientific exploration of space.

Exceptional Service

John T. Mengel, Assistant Director, Tracking and Data Systems, for his outstanding contributions to the mastery of space flight as demonstrated by the development and operation of world-wide networks for tracking, data acquisition and communications in support of NASA space programs, manned and unmanned, scientific and applied, and for leadership in the development of the basic operational concepts that have resulted in efficient program support by these facilities as recently evidenced in the Gemini VI and VII rendezvous flights.

Harry Press, Project Manager, Nimbus, for superior technical and administrative achievement contributing greatly to the World's understanding of weather through unique and integrated government-industry endeavor.

Herbert I. Butler, Chief, Operational Satellites Office, for outstanding achievement leading to the Nation's first operational weather satellite. His role in carrying out the joint cooperative effort between NASA and the Environmental Science Services Administration resulted in the early transition from research and development to operational use of the TIROS satellite.

Wilfred E. Scull, Project Manager, OGO for significant achievement in science and engineering that have advanced man's knowledge of the sun-earth relationship.

Arthur S. Flemming Award

Dr. Wilmot N. Hess, for his contributions as Chief, Laboratory for Theoretical Studies, in directing research in the geosciences, plasma physics, atomic physics, astronomy and celestial mechanics to broaden man's understanding of the earth's environment and for his pioneering research in the exploration of the Van Allen radiation belts.

Princeton Mid-Career Award

Bernard Sisco, Deputy Assistant Director for Administration, for study at the Woodrow Wilson School of Public and International Affairs.

Individual Training Award

James C. Reese, Head, Employee Development Branch, Manpower Utilization Division, jointly awarded by the Washington, D. C. Chapter, American Society for Training and Development and the Training Officer's Conference.

Harry Diamond Award

Dr. Rudolf A. Stampfl, Chief, Systems Division, Technology Directorate, for outstanding achievements in the organization, direction, and management of a highly complex engineering organization and personal technical achievements that have contributed greatly to the leading position of the United States in the exploration of space.

Awards for Patentable Inventions

Richard Schmidt, A Method of Matching Complex Impedances; John Paulkovich, Ampere-Hour Integrator; Clarence Cantor, Amplifier Clamping Circuit; Thomas Hennigan, Apparatus for Measuring Swelling Characteristics of Membranes; Abe Kampinsky, Apparatus Providing a Directive Field Pattern and Attitude Sensing of a Spin Stabilized Satellite; Joseph Sherfey, Bonded Elastomeric Seal for Electrochemical Cells; William Hungerford, John Larmer and Maurice Levinsohn, Conforming Polisher for Aspheric Surfaces of Revolution; William Kitts and Philomen Platt, Cryogenic Connector for Vacuum Use; Alfred Eubanks and Thomas Sciacca, Device for Measuring Electron-Beam Intensities and for Subjecting Materials to Electron Irradiation in an Electron Microscope; Paul Feinberg and Marjorie Townsend, Digital Telemetry System; Philip Studer, Electron Beam Switching Commutator; Daniel Grant, Fluid Flow Meter; John Bauernschub, Folding Boom Assembly; Edward Mayo, Hypersonic Re-Entry Vehicle; Abe Kampinsky, Method and Apparatus for Determining Electromagnetic Characteristics of Large

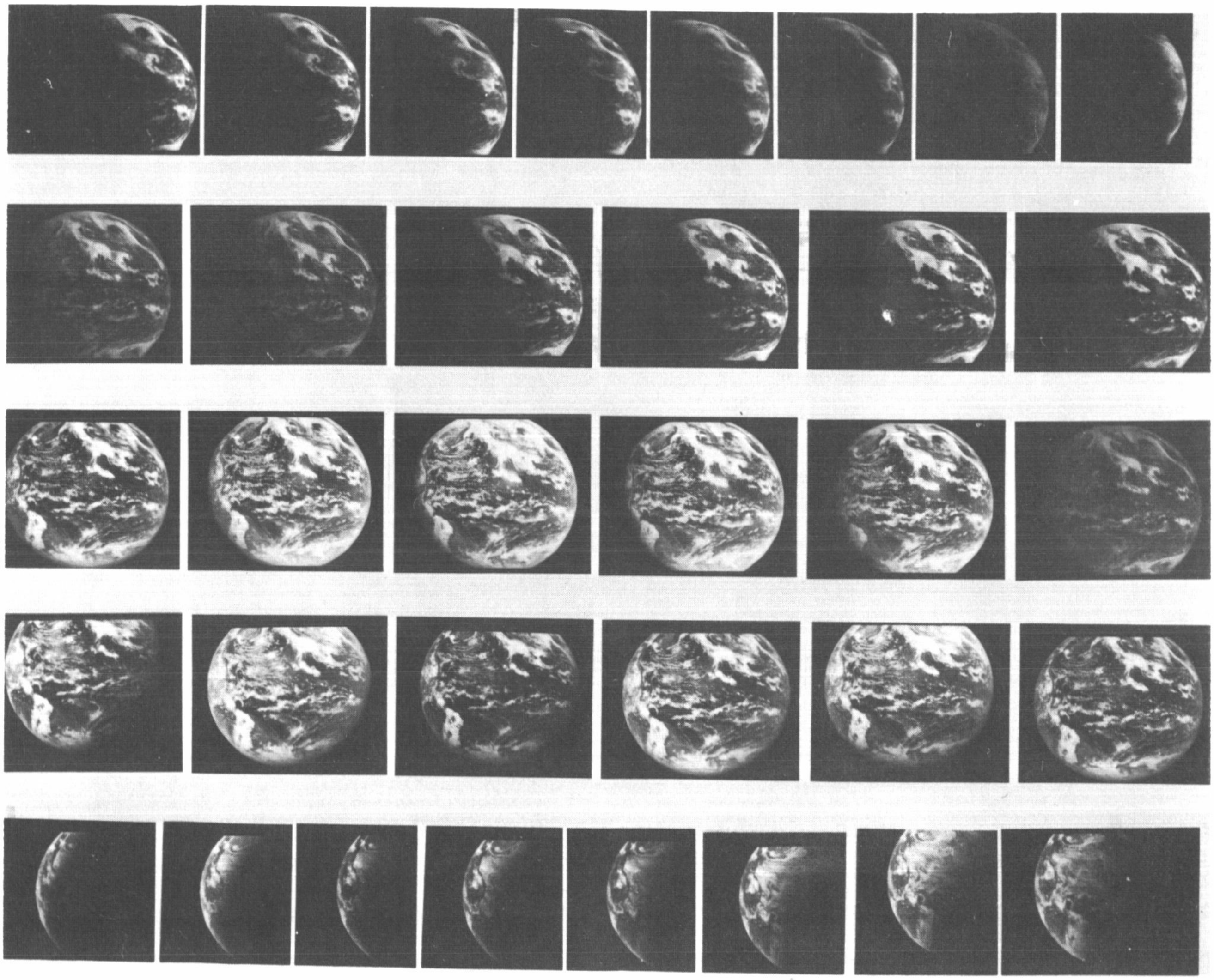
Surface Area Passive Reflectors; Grady Nichols, Method and Apparatus for Phase Stability Measurement of a High Frequency Signal Source; Joseph Conn, Moment of Inertia Test Fixture; James Bailey and Donald McAfee, Radio Frequency Coaxial High Pass Filter; Luc Secretan, Rotary Bead Dropper and Selector; Paul McCaul and Raymond Granata, Sideral Frequency Generator; Edward Mayo, Spacecraft—A Heat Shield Configuration; Karl Plitt and John Thole, Temperature Actuated Inflation Device; George Rinard and John Watson, Tumbler System to Provide Random Motion; Raymond Hartenstein, Variable Time Constant Smoothing Circuit.

SAFETY AWARDS

Industrial Accident Prevention Awards

Five-Year Award: Aerospace Experimental Machine Branch.

One-Year Award: Aerospace Metal Forming and Welding Branch; Instrumentation Section; Optical Test Section; Optics, Electro-Chemical and Plastics Branch; Plan Operations and Maintenance Branch; Test Development Section; Test Operations Section; Thermodynamics Branch.



Sunrise—Sunset. This series of photos was taken by the Spin Scan Cloud Camera on the Applications Technology Satellite-1, on December 11, 1966. The photos show the changing cloud pattern over the Eastern Pacific Ocean and the North, Central and South American continents for an 18-hour period beginning about 6:30 a.m. EST. These pictures were recorded at the ATS Ground Station in Rosman, N.C. The sequence reads from right to left, beginning at the upper right.

APPENDIX A

PUBLICATIONS AUTHORED BY THE GODDARD STAFF

TECHNICAL NOTES

JANUARY

D-3128 Musen, P., "On the High Order Effects in the Methods of Krylov-Bogoliubov and Poincare."

D-3168 Carpenter, L., "Planetary Perturbations in Chebyshev Series."

D-3174 Harris, D. and J. Berbert, "NASA-Mots Optical Observations of the Anna 1B Satellite."

FEBRUARY

D-3078 Carpenter, L., "Computation of General Planetary Perturbations, Part III, An Expansion of the Disturbing Force."

D-3086 Blanchard, R. and W. Hess, "Solar Cycle Effects on Inner Zone Protons."

D-3169 Young, R. and A. Stober, "A Soft X-Ray Photoionization Detector."

D-3170 Bahiman, H., "Post Launch Structural Analysis of the Echo II Satellite."

MARCH

D-3057 Demmerle, A. and T. Karras, "Signal Conditioning to Improve High Resolution Processing PFM Telemetry."

D-3079 Strong, J. and T. Saliga, "Comparison of Phase-Coherent and Non-Phase-Coherent Coded Communications."

D-3126 Staugaitis, C. and L. Kobren, "Strain Measurements Conducted on a Full Scale Echo II Passive Communications Satellite Balloon."

D-3167 Priester, W., "On the Variations of the Thermospheric Structure."

D-3172 Hertz, H., "The Use of Short Arcs in Orbit Determination."

D-3173 Flatley, T., "Equilibrium Shape of an Array of Long, Elastic Structural Members in Circular Orbit."

D-3211 Reber, D. and L. Hall, "A Double Focusing Magnetic Mass Spectrometer for Satellite Use."

D-3212 Harris, E., "Cosmology Without General Relativity."

D-3245 Forsythe, R., "Impulse and Thrust Test of a Sublimating Solid Micropulsion System."

D-3337 Mayo, E., "Newtonian Aerodynamics for Tangent Ogive Bodies of Revolution."

D-3338 Narrow, B. and M. Pasternack, "A Computer Program to Evaluate the Effectiveness of PCM Frame Synchronization Strategies."

D-3339 Dalle Mura, P., "An Ultra-Low-Noise 1700 Mcs Parametric Amplifier System.

D-3340 Piazza, F., "Computer Analysis of Interplanetary Monitoring Platform (IMP) Spacecraft."

D-3342 DiLosa, V., "Diversity-Locked Phase Demodulator."

D-3356 Cote, C., "Telemetry Data Frame Readout System."

D-3357 Herzig, H., "Uniform Vacuum Ultraviolet Reflecting Coatings on Large Surfaces."

D-3378 Charnow, M., "The Development of Hansen's Coordinates in the Lunar Problem by the Method of Iteration."

APRIL

D-2850 Batakeyama, L., "A Data Loading Routine for the IBM 7094 – 704X Systems."

D-3085 Franta, A., "Achieving Ariel II Compatability Design."

D-3292 Johnson, E. and T. McGunigal, "Hydrogen Maser Frequency Comparison with a Cesium Beam Standard."

D-3352 Carr, F., "Flight Report Interplanetary Monitoring Platform IMP I – Explorer XVIII."

D-3376 Parsons, D. and C. Harris, "IMP-1 Spacecraft Magnetic Test Program."

D-3377 Wainscott, F., "The Syncom III Launch."

D-3395 Balakrishnan, A., R. Kuntz, and R. A. Stampfl, "Adaptive Data Compression for Video Signals."

D-3396 Jamison, D., "Telemetry Computer Integration System."

D-3399 Cole, P., "Development of a Magnetic-Tape Static Friction Testing Device."

MAY

D-3154 Kampinsky, A., "Experimental and Theoretical Evaluation of a Passive Communications Satellite (ECHO II)."

D-3391 Stark, K., "Techniques for the Design, Evaluation and Analysis of Endless Loop Take Transports for Satellite Applications."

JUNE

D-3127 Allison, L. and H. Thompson, "TIROS VII Infrared Radiation Coverage of the 1963 Atlantic Hurricane Season with Supporting Television and Conventional Meteorological Data."

D-3353 Carr, F., "Flight Report Interplanetary Monitoring Platform IMP/II-Explorer XXI."

JULY

D-3091 COSPAR, "Goddard Space Flight Center Contributions to the COSPAR Meeting, May 1965."

D-3313 Wagner, C., "The Equatorial Ellipticity of the Earth as Seen from Four Months of Syncom II Drift Over the Western Pacific."

D-3315 Wagner, C., "The Equatorial Ellipticity of the Earth from Two Months of Syncom II Drift Over the Central Pacific."

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D-3316 Wagner, C., "The Drift of an Inclined Orbit 24 Hour Satellite in an Earth Gravity Field Through 4th Order."

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D-3470 Schmid, P., "Atmospheric Tracking Errors at S- and C-Band Frequencies."

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D-3562 Bonavito, N., "Computational Procedure for Vinti's Accurate Reference Orbit with Inclusion of the Third Zonal Harmonic.

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D-3617 Crockett, W. R., "A New Design Approach for Wide-Range Temperature Monitoring and Compensating Networks in Scientific Satellites."

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APPENDIX B
THE GODDARD SPACE FLIGHT CENTER

NASA Photos

by DR. JOHN F. CLARK, *Director,* GODDARD SPACE FLIGHT CENTER
National Aeronautics and Space Administration

Reprinted from SPERRYSCOPE, quarterly publication
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"We who are engaged in the hectic task of space exploration have little time to reminisce about past accomplishments and little inclination to speculate about future achievements beyond, at the most, a few years." The author therefore deals largely in the present as he introduces his readers to one of the important centers responsible for the nation's space program.

Looking back at our early years of space exploration, one fact becomes paramount: We have telescoped time and emerged with the means to explore space, to use it for the benefit of not only this nation, but of the world. The capabilities that we have built up have not just been placed in space, but rather have been anchored on the solid earth in laboratories, launch facilities, and in the dedication of the men and women who make up this co-operative team.

One can speculate — but it is only speculation — about what the future may bring. There are many avenues of exploration open: the moon, the space environment near earth, the planets, and even the galaxies. But without knowing what constraints we may encounter in the availability of people, dollars or objectives, such speculation can be a rather academic exercise. It is certain, however, that the years immediately ahead will be filled with intense activity in space, just as they have been in the past decade. We shall be expanding our knowledge and operational capability constantly. Only the rate of progress is uncertain.

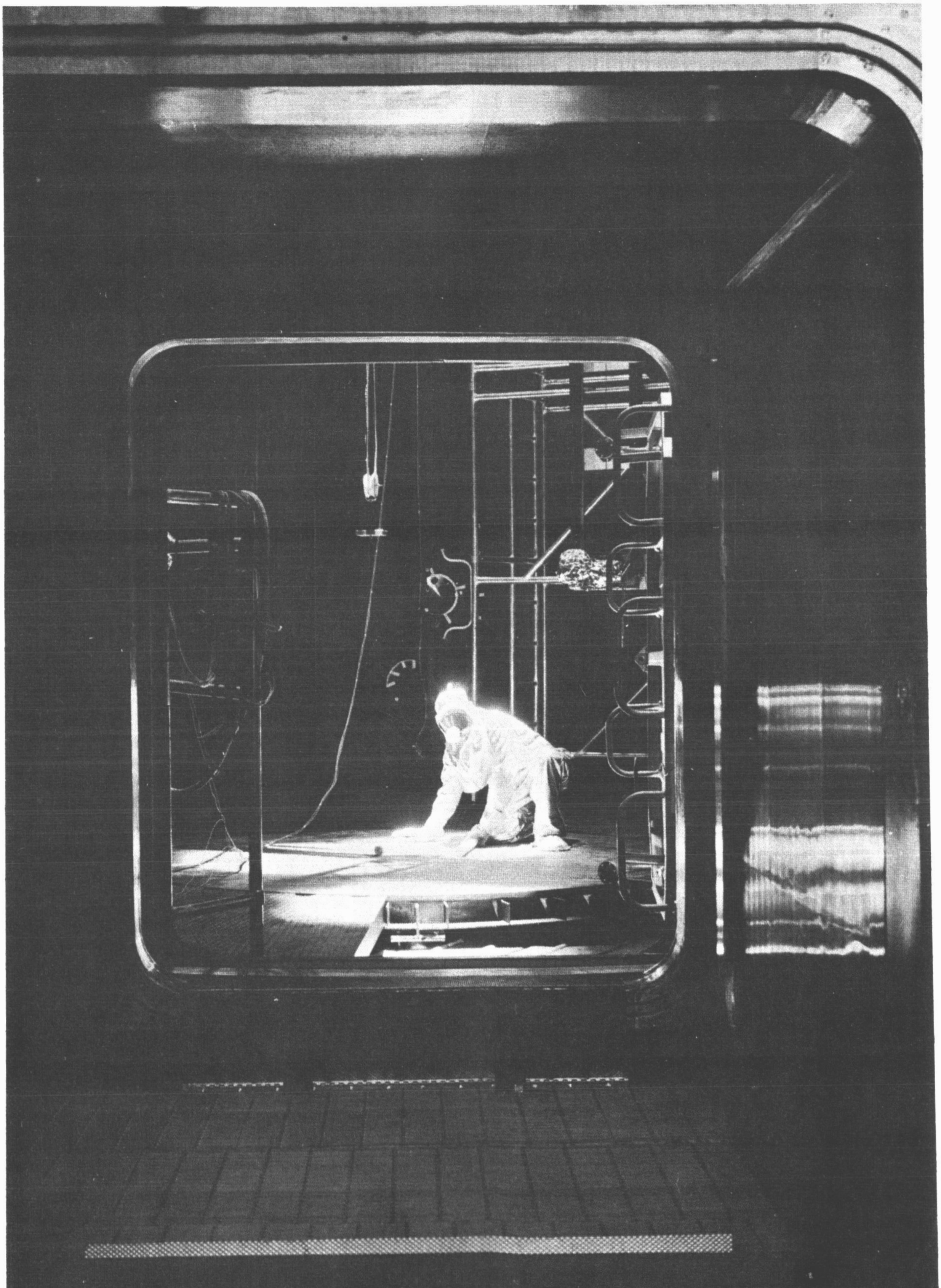
At Goddard, in the immediate future, we shall continue the scientific research begun with the first orbiting laboratories — the Orbiting Solar Observatory (OSO), Orbiting Geophysical Observatory (OGO), and Orbiting Astronomical Observatory (OAO), plus a number of specialized, smaller *Explorer* satellites.

In the applications area, launches will continue in the TIROS Operational System (TOS) series that we are conducting for Environmental Science Services Administration (ESSA). The *Nimbus* satellite will test more promising new instruments and techniques for improved weather forecasting from space. Flights of the Advanced Technology Satellite (ATS) will open new vistas of use in the fields of spacecraft orientation, meteorology, communications, and navigation.

Concurrently, we are up-dating our global tracking and data-acquisition networks. The STADAN network for unmanned spacecraft is being upgraded to handle the large amount of data we now receive because of the increasing complexity and number of experiments in our flight program. The Goddard-operated manned space flight network which performed so admirably during the *Mercury* and present *Gemini* programs, also is being improved for the increasingly complex task of communications and data-gathering associated with upcoming *Apollo* missions.

SOME GOALS

What are our principal goals? Let me mention four broad NASA objectives, none of which has experienced any radical change in purpose since organization of the agency in 1958. Subsequently, we can relate these objectives to what is going on at Goddard. The objectives are:



1. To expand human knowledge of celestial bodies and space phenomena.
2. To advance the technology of space flight and aeronautics.
3. To develop the capability to apply aeronautical and space techniques for peaceful uses of mankind.
4. To develop and maintain a broad institutional base for science and technology.

To carry out these overall objectives of NASA, Goddard is assigned responsibilities in several major areas. These include:

- Development of scientific satellites and experiments to study astronomy, solar physics, magnetic fields, energetic particles, ionospheres, radio physics, meteorology, and planetary atmospheres.
- Development of applications-type spacecraft for use in meteorology, communications, and navigation.
- Conduct of NASA's sounding rocket program, where lower-cost launch vehicles are used to investigate various scientific areas of interest and prove out future and more costly spacecraft instrumentation.
- Management of virtually all of NASA's tracking, communications, and data-acquisition activities, both for manned and unmanned spacecraft, with the exception of deep-space probes to the moon and planets.

The four principal objectives of NASA — gaining knowledge of the space environment, advancing technology of space flight, and using this newly gained wisdom for the benefit of man, while doing research over a broad spectrum of science and technology — have provided the heartline for Goddard since its inception on May 1, 1959. At that time, a nucleus of personnel from several Department of Defense laboratories started to build the research capability and plan the programs for what would become one of the world's largest space research centers devoted exclusively to the peaceful exploration of space.

DR. JOHN F. CLARK

Dr. Clark, an internationally known authority in the field of atmospheric and space sciences, came to Goddard Space Flight Center May 5, 1966, from NASA Headquarters, where he was Deputy Associate Administrator for Space Science and Applications (Sciences).

During a career at NASA extending over the past eight years, he has served in key positions, giving scientific management direction to research in astronomy, atmospheric physics, bioscience, energetic particles and fields, ionospheric physics, meteorology, manned space science, planetology, and solar physics.

Author of more than a score of scientific papers, he previously served with the Naval Research Laboratory in Washington, D.C.

Dr. Clark is a native of Reading, Pennsylvania. He received his B. S. degree, with honors, from Lehigh in 1942, his M. S. degree in mathematics from George Washington University in 1946, and his Ph.D. degree in physics from the University of Maryland in 1956.

Through experiments carried on sounding-rocket flights, orbiting *Explorer,* and applications satellites, various international co-operative flight programs, and our large orbiting observatories, and through our supporting theoretical and laboratory research, Goddard has consistently maintained a vigorous program to expand our understanding of space phenomena. We know such efforts will give insight into and lead to an understanding of the fundamental nature of the universe that can be obtained in no other way.

NO SHORTCUTS

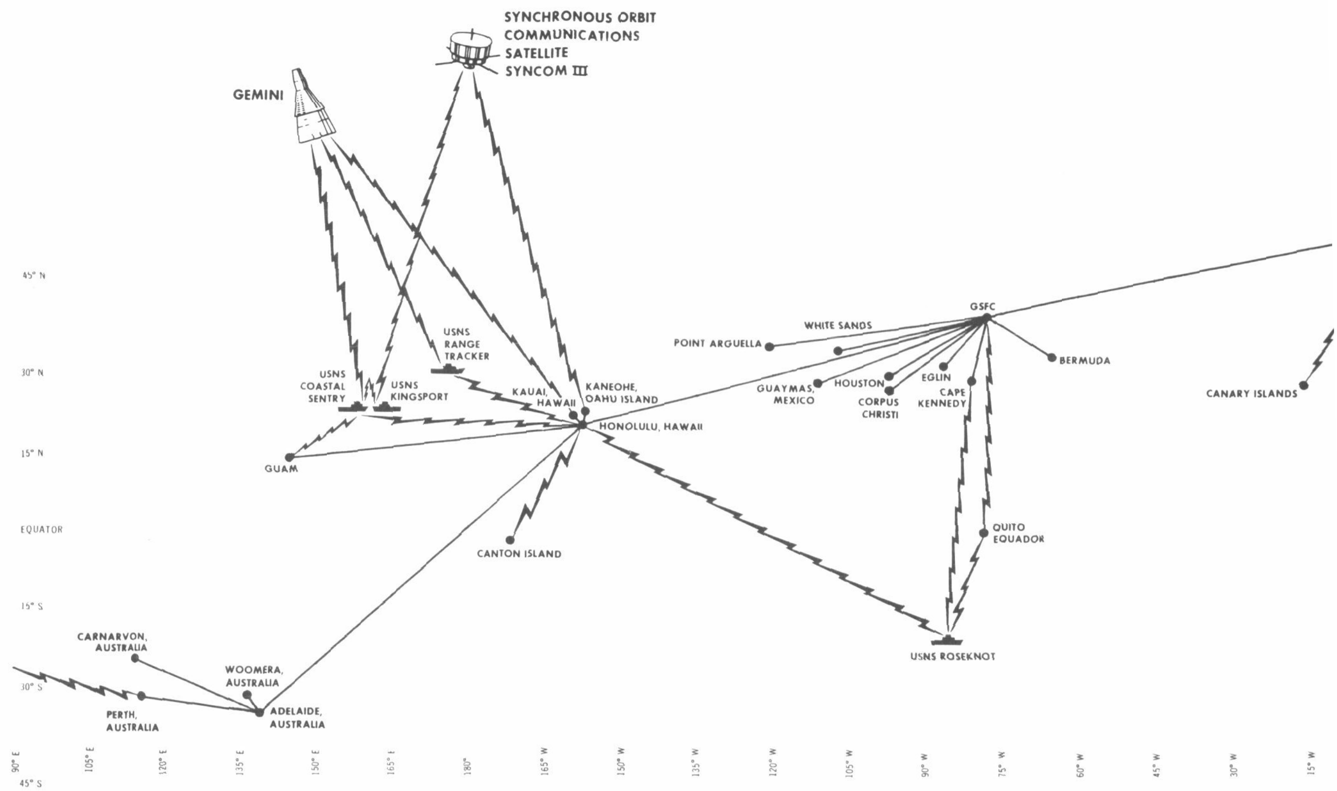
But in space, as on the earth, great prizes are not won easily or cheaply. People are usually shocked when they are told that there can be a seven- to nine-year time span for an experiment on one of our large satellites. That extends from conception of a space experiment; designing and building the experiment; launching the spacecraft; recovering, processing, analyzing, and sifting the data; and then publishing the results.

Take the Orbiting Geophysical Observatory (OGO) Program as an example. Selection of an experimenter usually occurs from two to three years before a flight, and there are interactions between NASA people and the scientist even before that. From nine months to a year and a half before launch, time is spent in building the flight instruments. During this interval, the scientist-experimenter also must produce detailed plans on how to handle the data he gets from his experiment. From three months to a year or more after launch, the experimenter normally publishes his preliminary results, but his long-term analysis may take several more years after receipt of the final data from the experiment, which may, in turn, be several years after the launch.

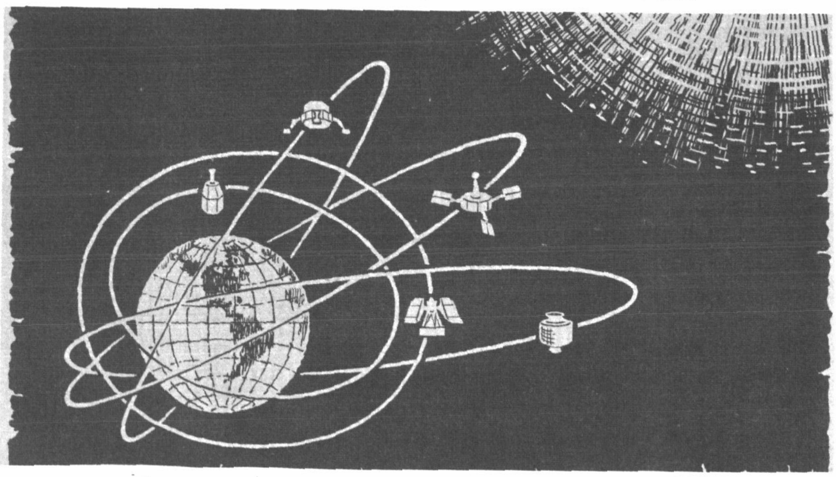
In the *Explorer I* satellite, when only a single geiger counter was flown, the amount of data was relatively small. Since the Van Allen radiation regions were discovered by that satellite, it became important to study in detail the nature and energy of the particles, to map their directional distributions and their associated magnetic field in space, and to study their variations as a function of time to gain a reasonably complete picture of these phenomena.

This research has resulted in quantum jumps in the number of data points that must be processed and analyzed to get a meaningful picture.

Technician in Space Environment Simulator. Silver suit protects against ultra-violet energy from simulator's "sun." Headpiece filters out ozone.



Goddard is NASA's communications center. It operates world-wide network that provides teletype, voice, and data links between remote stations and Mission Control Center at Houston. At nerve center of network are two UNIVAC® 494 Real-Time Systems.



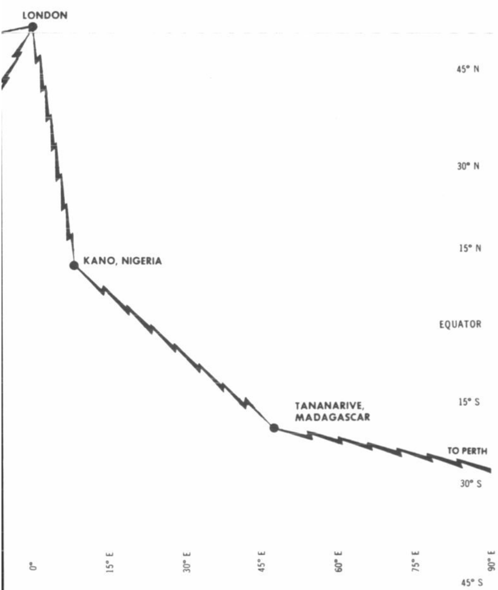
For example, to adequately display the neutral plasma sheet in the so-called comet-like magnetosphere tail of earth partially mapped a year ago by a Goddard experimenter, more than 5 x 10^5 data points, or six months of data, were represented on one graph.

The amount of data coming from space is even more impressive if we consider the first two OGOs, which were officially classified as technological failures but still accomplished most of their scientific objectives. We had planned 22 x 10^9 data points for a year of operation at 10 per cent of the time for OGO-I, and we actually received 9 x 10^9. For OGO-II, 3.3 x 10^{10} data points were planned and 1 x 10^{10} were received. The two spacecrafts fill 70 to 80 reels of digital tapes each day. This demonstrates that space experiments are long, arduous, and tedious investments of time and facilities, but the significant results gained from these experiments have shown us that they are well worth the effort.

By carrying out scientific investigations in space we are satisfying man's centuries-old desire to understand our planet, the space environment of which it is a part, and the control exercised over it by our life-giving sun. There is nothing like the hard facts of direct measurements to up-date and at times overturn many supposedly infallible theories and concepts we had of this environment less than 10 years ago.

To cite only a few examples, we now know that the earth is not as perfectly round as we had supposed, but gather that it has a slight pear-shape, with flattening at the poles and bulging at the equator. We also know that our atmosphere does not end a few hundred miles above the surface of this planet but rather, in the form of the great radiation regions, extends outwards many thousands of miles toward the sun and many tens of thousands of miles away from the sun. Additionally it was found that neither near-earth space nor that of the interplanetary medium is a quiescent void, as previously conceived, but that each is an immense region of activity where radiation from the sun, the solar wind and its associated magnetic field, and energetic particles — all play a vital role.

Even though Goddard, in partnership with about 50,000 other workers in government, industry, and the university communities has launched more than 50 satellites and hundreds



of sounding rockets — all containing scores of experiments in many scientific disciplines — we still do not understand some of the mechanisms underlying these space phenomena. For example, how are the sources of energy in the sun propagated through the outer layers of the solar "atmosphere" and the interplanetary medium, and what are the detailed absorption processes in the earth's atmosphere?

Answers to these questions will be slow in coming. Undoubtedly they will take many more years of research — perhaps several complete solar cycles — before most of the jig-saw-like pieces can be put together in an understandable working model. But these are questions that must be answered because they involve the energy required for all life on earth, processes which may determine our weather and affect significantly our ability to travel safely in space and to communicate over large distances on the earth.

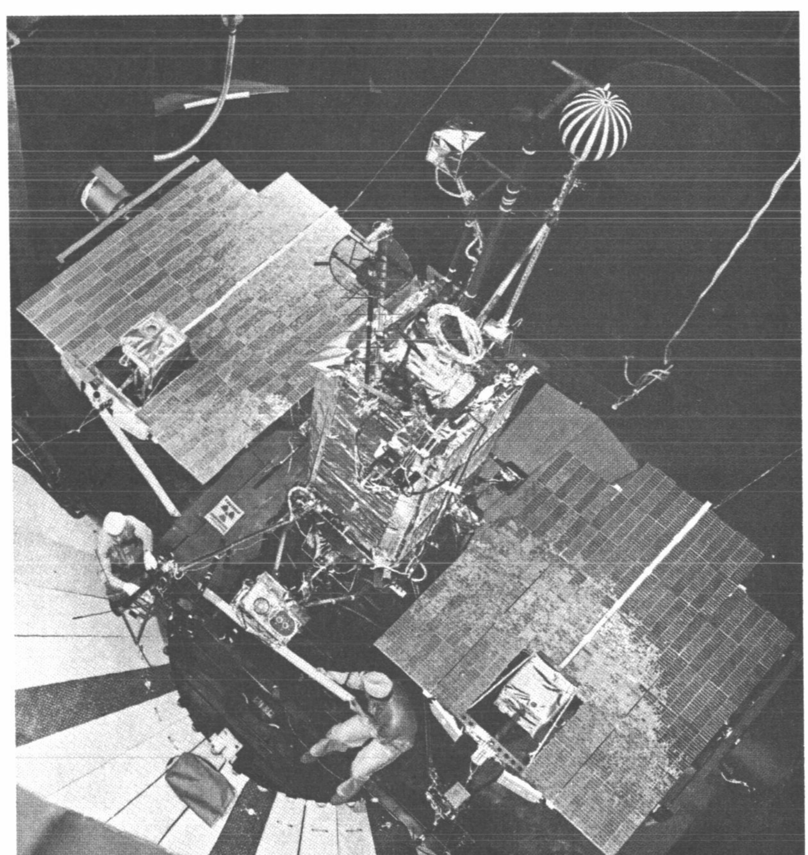
To help supply these answers, NASA and Goddard over the years have attempted to spread the problems over the largest possible number of able minds. This practice has succeeded admirably in generating creative thought which has been translated into new theories, processes, methods, and hardware that are enabling us to continue our research over a broad spectrum of effort. All of this has put us in the rather enviable position of being able to define challenging programs — and pursue them — subject to the necessary constraints of budget, personnel, and national objectives, rather than react to challenges resulting from the activities of others.

Starting in 1959 with a staff of 398 on 550 acres of scrub pine land at Greenbelt, Md., the Center now is a $250 million complex of 50 buildings and facilities occupying nearly 2 million square feet of space on nearly 1200 acres. We have a scientific, engineering, technical, and administrative staff of 3,700 people. More than half of this number are holders of university degrees. Some 1,570 people are engineers and scientists. Ph.D.s account for 123 of this category; persons having Master's degrees total 279; and the remaining 1,190 have Bachelor's degrees.

Starting with a $4 million budget in fiscal year 1959, the Center's present FY 1966 budget is over $400 million, of which 95 per cent of the procurement dollars are spent with industry, universities, and other groups.

Educational and professional advancement are important to our people. In calendar year 1965, for example, Goddard professionals authored 96 formal NASA publications, submitted 233 articles to professional journals, and made 380 presentations before professional society groups.

The desire for educational advancement is startlingly reflected among our technicians. Out of a total of 557 technicians, more than 100 of these people last year took "on-Center" courses in computer technology, engineering, electronics, etc., for professional improvement. Attendance for part-time graduate training at local area colleges and universities averages 300 people per semester, while more than 120 Center colloquia for professional betterment were held last year.



OGO-III, now circling the earth once every two days, is in an orbit with altitudes ranging from 75,768 miles to 170 miles. Here it is shown undergoing preflight tests.

APPENDIX C

TRACKING, COMMAND, CONTROL AND DATA-ACQUISITION OF NASA FLIGHT PROGRAMS*

Harold L. Hoff
Chief, Network Engineering and Operations Division

During the six years since 1958, NASA's flight program requirements for ground support have increased in amazing proportions. The Tracking and Data-Acquisition support required for Vanguard I was CW tracking on a single frequency beacon coupled with relatively accurate frequency measurements of the same beacon to measure space temperatures. No command capability or special telemetry reception was required.

Today NASA's programs require a system of three world-wide tracking and data-acquisition networks. The Manned Space Flight Network, specifically instrumented for manned spacecraft support, began with the highly successful "Mercury" Program and will soon support the Gemini and Apollo Projects.

A second, the "Deep Space" Network, is especially located and equipped for lunar and planetary exploration by spacecraft projects such as Mariner, Ranger and Voyager.

The third network called the "Space Tracking and Data-Acquisition Network" or STADAN, is the oldest operating U.S. network and the only network which is required to handle multiple spacecraft missions simultaneously. Both the Manned Space Flight Network and the Deep Space Network are designed to handle a single spacecraft mission at any given time.

This "work horse" network, the STADAN, is required to support multiple scientific spacecraft and probes in orbit around the earth extending out as far as the moon.

This multiple purpose network, supporting 25 different spacecraft in orbit at the end of December, 1964, will be the example for discussion in this presentation.

Tracking

Historically, the first functional system to be constructed for satellite tracking was the Minitrack system. This system was transferred to NASA at the time NASA was established, and formed one of the basic building blocks of the present NASA Space Tracking and Data-Acquisition Network. Minitrack uses radio interferometers which measure two of the three direction cosines of a line from the system center to a transmitting satellite, as a function of time, while the satellite passes through the beam pattern of the receiving antennas. The reference lines for these measurements are orthogonal in the plane of the ground antennas. The third direction cosine is thus implicitly defined, and the angular position of the satellite is determined. From a series of independent angle measurements made at various ground stations, satellite orbits can be determined to a great accuracy by computer methods.

Minitrack performs its angular position measurements by phase comparison techniques to measure the difference in arrival time of the wavefront from a satellite source at each antenna of a pair of antennas separated by known distances in wavelengths. Measurement of this radio path difference is accomplished by a comparison of the phase angle of the signal received at one antenna to that received at another. Antenna pairs are aligned along east-west and north-south baselines to form a convenient coordinate system.

Since the accuracy of the measurement of the angles increases as the length of the baseline between the antennas increases, two pairs of antennas are aligned along orthogonal baselines many

*Annals New York Academy of Sciences, 1966.

wavelengths long to obtain good angular resolution. As a radio source travels through the antenna pattern, the relative phase will cycle from zero to 360 electrical degrees for each wavelength added to the radio path difference. Because the phase meters repeat their readings every wavelength, a number of different space angles produce identical phase readings during a satellite transit. This ambiguity is resolved by employing several progressively shorter baselinse which produce fewer integral numbers of wavelength changes while the satellite moves through the antenna beam.

While the Minitrack system functions extremely well with conventional earth satellite orbits, spacecraft with highly eccentric orbits do not lend themselves well to tracking by an angle-measuring system. An eccentric orbit can mean an orbital period of many hours, and such relatively slow angular motion at or near apogee, as to exceed the precision of the basic angular measurements by radio interferometers. Satellite orbital parameters must be determined as rapidly as possible in order to extract maximum usable data from the spacecraft. Range and range rate systems can provide more direct and meaningful measurements than space angle measurements when working with highly elliptical orbits. Accordingly, a range and range rate measurement system has been developed and is operational. The range and range rate system functions as a high precision spacecraft tracking system capable of accurately determining the range and radical velocity of a spacecraft from near earth orbits out to cislunar distances.

The range of spacecraft can be determined by measuring the travel time of an electromagnetic wave. Knowledge of the propagation velocity gives the distance. This can be accomplished either by using a pulse as in the radar principle, or by measuring the phase of the electromagnetic wave traveling from a transmitter to the spacecraft and back to the ground station receiver by means of a ranging transponder in the spacecraft. The latter principle is applied here and is known as sidetone ranging. A carrier is modulated with several mathematically related frequencies, and measuring the phase of these related frequencies after transmission to the spacecraft and return enables the determination of range. This in essence is a time measurement.

Since the carrier is a CW signal, its Doppler shift can be measured very accurately, particularly at frequencies above one gigacycle where the effects of the ionosphere are small. Since the Doppler shift is proportional to the range rate, the range rate can likewise be measured with great precision, provided that the short-term stability of the ground-based oscillator, during the travel time of the transmission from to spacecraft and return is very good.

Because this system involves no angular measurements, tracking errors at great distances are minimized. Furthermore, the use of a coherent CW system offers another twofold advantage over a pulse system. Extremely narrowband techniques are permissible which make for improved signal-to-noise conditions and greatly reduced power requirements.

Each range and range rate station employs two distinct systems: an S-band system and a VHF system. For use with the S-band system, a three-channel ranging transponder is installed in the spacecraft. This permits tracking computations from data supplied by a single ranging station, or computations from data supplied simultaneously by a complex of two or three stations. The VHF system is used primarily for acquisition, but is also used for ranging when the spacecraft cannot carry the S-band, three-channel transponder. In this case, a VHF transponder is used which functions as a command receiver, telemetry transmitter, and a single-channel ranging transponder.

Thus the tracking configuration may be either that of a single range and range rate station operating independently, or a complex of up to three stations operating simultaneously.

Each ranging station can measure spacecraft range with a resolution of ±15 meters, and range rate with a resolution of 0.1 meter per second.

At those stations equipped with a Minitrack phase interferometer system, the equatorially-mounted astrographic camera, used for periodic aircraft calibration of the interferometer system, has been adapted for optical tracking of earth satellites. The camera has an ultralinear f/5.0, 40-inch

focal length lens, and uses 8 × 10 inch spectroscopic plates, affording an ultimate star resolution accuracy of better than one second of arc over an 11 × 44 degree field of view. The camera is driven at a sidereal rate, thus permitting stars as faint as eleventh magnitude to be photographed. A serial time code developed from the station's time standard is used to actuate a solenoid which moves a plunger to displace the film plate within its holder. The satellite photographs as a trial of light against a star background interrupted by breaks corresponding to time code pulses. The photographic plates are compared to star charts, and preliminary reductions are made at the tracking stations. Whenever possible, photographs are taken while the satellite is in the main antenna beam of the Minitrack interferometer system, and the corresponding radio records are mailed to Goddard along with the photographic plates for correlation of radio and optical tracking data. This tracking system has proven extremely successful with the Echo satellites, achieving accuracies within a few seconds of arc.

Optical tracking is used for only a very small percentage of tracking information. The major optical tracking for NASA flight programs is accomplished by the Smithsonian Astrophysical Observatory's Optical Network using the specially designed "Baker-Nunn" Camera System.

Command

Command interrogation requirements for present and future spacecraft are both varied and complex. Simple "playback" or "turn-on" command requirements have been replaced with multiple command, address-execute and command verification sequences exercising a variety of spacecraft sensors. Such detailed programs often require computer programming of command sequences, either in advance of actual spacecraft contact, or in real-time activity during spacecraft contact and data acquisition.

Ground support transmitters, operating at discrete frequencies in the area from 120 to 155 Mcs, are located throughout the world-wide network of ground stations. Transmitters capable of outputs of 200 watts, 3 kilowatts and 5 kilowatts are presently in use and installation of variable outputs transmitters capable of delivering 250 watts to 2.5 kilowatts is planned in the very near future.

In the past, systems used for transmitting commands to satellites have utilized elementary tone-actuated devices. These have been used to relay one or two simple switching commands and have been adequate for the purpose. However, current and future satellites require more complex interrogations, necessitating multiple tones. Reasonable separation of the audio frequencies is mandatory, thereby placing a limit upon the number of frequencies available within the command band.

In anticipation of an eventual saturation point, a more versatile type of digital coding was devised.

These digital encoders are capable of working at a postdetection signal-to-noise ratio of 1 to 1. This, in itself, is a great advantage over the tone system which requires a 20- to 30-db signal-to-noise ratio.

The system may be operated in any one of three modes: manual tone command selection, manual digital command selection, and automatic tape reader control for either tone or digital command sequences.

The tone encoder generates 30 tone bursts between 1,025 and 11,024 cycles. The digital encoder produces a total of 90 separate digital commands. The commands are PCM coded and are used to either modulate the transmitter carrier to produce the PCM/AM/AM mode, or to key the transmitter "on" during pulses and key it "off" between pulses to produce the PCM/AM mode.

Even more advanced digital command encoders are being used for the "Observatory" class of spacecraft. Command sequences require transmitting an "address" command to reach the correct experiment area in the spacecraft, followed by a "function" command which will activate the correct experimental unit or device. In some cases, the "address" and "function" commands are received by the spacecraft, and held until verified at the ground station by a transmission from the spacecraft before a final "execute" command is transmitted to initiate the desired experimental activity. Many such sequences of command programming are executed in less than milliseconds during "contact" periods that may extend

to many hours for one spacecraft assignment at a single ground station.

The major command antenna system utilizes an antenna array coupled to an X-Y mounted, hydraulically driven pedestal. The antenna drive system can be slaved to a separate acquisition antenna, or driven by a tape programmer console.

The broadband, high power command antenna consists of an array of nine disk-on-rod structures each composed of 14 disks above a crossed-dipole driver. These arrays are capable of transmitting 5 kilowatts of average power and of operating over the frequency band from 120 to 155 megacycles.

Other command antennas use a single disk on rod type element mounted on the edge of a large parabolic data acquisition antenna or multiple element yagi arrays on electric motor-driven mounts.

Data-Acquisition

Operational data-acquisition for present and future spacecraft necessitates earlier and more reliable acquisition of telemetry signals, coupled with automatic aiming capability to maintain accurate contact during long periods of experimental data retrieval. To meet this need, Automatic Tracking Antennas have been implemented to provide the network stations with telemetry antennas capable of fast, accurate positioning and full sky coverage, over a variety of spacecraft telemetry bands.

One basic telemetry array consists of four quadrants of yagis, each quadrant composed of four yagis, individually consisting of five parasitic elements above a driven element. The yagi spacing in each quadrant is one wavelength, and the quadrants are spaced two wavelengths on centers. The pedestal is a hydraulically-driven X-Y mount. The antenna is designed for operation on a center frequency of 136.5 Mcs, for use over the 136-137 Mc band.

Three servo operational modes are possible: automatic, manual and slave. Separate autotrack and telemetry-data receivers are employed. Flexible selection of antenna polarization and receiver frequency is also provided. The autotrack receivers provide control voltages to the servo-system. An angular error between the antenna pointing direction and the satellite line-of-sight results in a phase difference in the RF signals received by antennas of the array; this phase difference is converted to error voltages which serve to correct the antenna position, and maintain automatic aiming on the orbit path.

This general purpose telemetry antenna, used for 136 Mc telemetry support has a gain of 22.5 db and covers the entire sky hemisphere above 7 degrees from the horizon.

Some satellites already launched by the National Aeronautics and Space Administration, and many satellites to be launched in the near future, use very wide bandwidths for transmission of data on the ground stations. Since the receiver noise and sky noise in the telemetry link is proportional to the bandwidth used for reception, either a very high transmitter power in the satellite or a very high antenna gain on the ground must be used for a wideband telemetry link to achieve good signal-to-noise ratios. The satellite transmitter powers are somewhat restricted due to payload weight constraints and consequently, it is necessary to use very high-gain antennas at the ground station for reception of wideband telemetry signals. These satellites will use several of the frequency bands assigned for space use. Therefore, the high-gain antenna must have the capability of operating at several frequencies. The antennas that best satisfy these requirements of high-gain and multiple frequency operation are parabolic antennas of 40 or 85 feet in diameter. The high-gain parabolic antennas are required for reception from such diverse satellites as the polar orbiting Nimbus series, the low-inclination, low eccentricity Orbiting Astronomical Observatories (OAO), and the highly eccentric Geophysical Observatories (EGO).

The 40-foot diameter parabolic antennas installed in the network have a focal length of 16 feet. The surface consists of double-curved aluminum sheet panels, separated from the reflector structure so that the antenna panels can be adjusted independently. The rms deviation from the least square, best fit paraboloid does not exceed 1/32 inch. The aluminum surface of the reflector

is painted with a special white paint to scatter solar radiation.

The antenna is X-Y mounted. It is capable of tracking at rates from 0.005 degrees to 5 degrees per second, and can be accelerated up to 5 degrees per second squared as required. Pointing accuracy is ±60 seconds of arc. The antenna has five operational modes: automatic tracking, programmed drive, slaved to an acquisition antenna, and various scan modes for initial acquisition.

The antenna feed is supported above the reflector above a quadripod. The feed system for automatic tracking is a cluster of two monopulse systems on 136 and 400 Mcs.

The largest data acquisition antenna in this network is an 85-foot diameter paraboloid of revolution with a focal length of 36 feet. The surface consists of double-curved aluminum sheet panels, or parabolic sections of honey-combed aluminum construction. This surface is also separated from the reflector structure so that it can be independently adjusted. Experience with two antennas of this type indicated that the antenna surface can be more accurately adjusted and will maintain a tolerance of less than 1/16 inch deviation from the least square determined, best fit paraboloid. The aluminum surface of the reflector is also painted with a special flat white paint for scattering of solar radiation.

The antenna reflector is mounted on an X-Y type mount designed specifically for tracking satellites. An X-Y mount has two transverse roll axes. The advantage of this type mount for tracking satellites is that there are no gimbal-lock positions in the sky area above the horizon. This allows optimum tracking of satellites without requiring excessive shaft velocities from the antenna drive system.

The antenna is capable of tracking at rates from zero to 3 degrees per second, with accelerations up to 5 degrees per second. The pointing accuracy is ±40 seconds of arc. The antenna has five operational modes. It will automatically track on a satellite signal, it can be driven by a teletype drive tape input, can be manually operated, slaved to an acquisition antenna, or operated in various search modes for initial acquisition.

The antenna data system provides for the measurement, digital encoding and readout of the antenna shaft angles for feeding into the servo system, and are also readout by teletype punch for transmission to the computing center. These position and data quality codes are punched onto five-level paper tape in teletype code once each ten seconds. The console displays and the servo-system receive these data once per second. The resolution of the digital encoder is 0.002 degree and the rms accuracy is 20 seconds of arc. The data system includes a small computer and associated electronics which accept antenna drive tape predictions (received via teletype), and generates one-second predictions by interpolation. The data system then compares the one-second predictions to the actual antenna position and generates a velocity error signal for operation of the servo-system while in the program mode.

The antenna feed system has been equipped to provide autotrack capability in 136,400 and 1700 Mc bands. This feed system is a cluster of three feed systems for monopulse operation to provide automatic tracking. The feeds operate in autotrack mode in any of four polarizations: two orthogonal polarizations are provided, either linear or circular. For 136 and 400 Mcs, the operator at the control console can select the polarization desired by positioning a switch on the console. For 1700 megacycle operation the desired polarization is manually selectable by component substitution in the antenna feed network. Standard monopulse circuitry with coaxial hybrids is used for obtaining the sum channel and tracking channel outputs from the array of four polarization diversity elements.

The support for the antenna feed system on the reflector surface is a quadripod. The head of the quadripod is a hollow structural square cylinder designed to hold an integral feed and receiver box. The receiver box is four feet square and six feet long. The 400 Mc and the 1700 Mc feeds are mounted on the reflector end of the receiver box. This box slides into the support cylinder on the quadripod from the outside of the structure. The box is positioned by alignment mechanisms so that the receiver box and antenna feed can be easily removed for servicing and then returned to precisely the same position. This provision eliminates the necessity for alignment and boresight adjustments after a replacement of the receiver package.

The 136 Mc feed system is mounted on the actual quadripod legs due to the larger size of the antenna elements at this frequency.

Telemetry Link Concept

The massive quantities of telemetry data transmitted from today's multiple experiment spacecraft, coupled with numerous spacecraft in orbit at any one time, require extremely flexible, and widely versatile telemetry links in the ground network. A basic telemetry link requires a suitable antenna system; a signal detection, and amplification telemetry receiver system: data conditioning and data handling equipment; plus a data recording system. Each ground station does not contain a signal telemetry system but is equipped with two, three or even four basic telemetry links. Additionally, the components of a telemetry link are not constantly connected to a particular data acquisition configuration, but all telemetry link equipment is available to be electrically switched or coupled into any arrangement of antenna, receiver, data-handling and recording complex required. Telemetry link switching and configuring consoles are "preprogrammed" by plug-in boards which indicate, by illuminated displays, the particular telemetry link configuration needed for a specific spacecraft in orbit. The required equipments are then switched into the specific telemetry link that matches the support requirement. In this manner, the maximum capability for spacecraft data-acquisition is maintained throughout the network. Redundant component equipments are included to guarantee uninterrupted data flow and to allow suitable maintenance servicing without depreciating overall data-acquisition capability.

Available for use with any of the previously described antenna systems are the following basic components needed to complete a variety of telemetry links.

Telemetry Receivers

The Minitrack Mod I telemetry receiver system is tunable over a frequency range of 136 to 137 Mcs in 1 kilocycle steps. It was designed and constructed to provide maximum accessibility and flexibility of operation. Each receiver is backed up by a second identical receiving system.

The Mod I telemetry receiver is a triple conversion, vacuum tube, receiver with IF outputs brought out after each conversion stage. The second and third IF stages each provide two selectable bandwidths, making a total of five predetection bandwidths from 10 kilocycles to one Mc to permit suitable bandwidths matching the sideband construction of various telemetry signals.

Both vertical and horizontal polarization outputs from the data acquisition antenna are fed into a low-noise, dual-channel preamplifier mounted on the antenna proper. This unit establishes the system noise figure at about 2.5 to 3.5 db, provides sufficient gain to overcome losses in the transmission lines and associated components, and provides part of the filtering necessary for image rejection.

The horizontal and vertical outputs of the preamplifier are brought into the operations building on coaxial cables and into a polarization differentiation unit which allows simultaneous selection of four modes of polarization: horizontal, vertical, and right and left circular. To assure correct polarization differentiation, the electrical length and relative phase of both transmission lines, from the antenna output terminals to the polarization selector box, are made precisely equal by means of a mechanical "line stretcher".

A solid state diversity telemetry receiving system is the most recent addition to the network and is designed to provide polarization diversity reception of satellite telemetry signals. Tunable in one kilocycle steps, the basic receiver is capable of reception in the region from 130 to 140 Mcs simultaneously on both channels. When operated in conjunction with fixed tuned converters, it is capable of reception in the 400 and 1700 megacycle bands as well. To permit matching to signal sideband content, six predetection bandwidths between 10 kilocycles and 3 Mcs are selectable. The system features AM and FM demodulation, postdetection diversity combining, predetection output capabilities, and a visual presentation of the signal spectrum.

Data-Handling Equipment

A Pulse Code Modulation (PCM) signal conditioning console is used to achieve bit synchronization and signal reconstruction of serial PCM signals as detected by the receivers. The data and clock outputs from the signal conditioner may then be recorded or used for real-time display of significant spacecraft measurements by peripheral equipment. The console also contains a signal simulator and comparator for checkout and performance analysis of the signal conditioner, by the operator, prior to a spacecraft pass. To completely close the loop on performance evaluation the console has a single channel decommutator and error counter to enable the operator to observe any one data channel during the entire spacecraft passage over the ground station.

The PCM data-handling equipment is a universal PCM telemetry data-handling system capable of accepting serial PCM data from a number of sources including telemetry receivers, magnetic tape recorders, or the PCM simulator within the system itself.

The input to the signal conditioner is PCM video in serial form from various sources. The signal-to-noise ratio is optimized by appropriate filtering. This unit then detects and reconstructs the serial signal pulse train and develops the master clock signal from the incoming data, phase coherent with the incoming bit rate. The bit rate is selectable from one bit per second to 200,000 bits per second.

Provision is made to handle either return to zero (RZ), nonreturn to zero (NRZ), or split phase (S/P) signal formats. The regenerated output of this unit is always in the NRZ form.

The synchronizer subunit accepts the regenerated serial data from the signal conditioner and formulates this data into two major types of outputs: a serial data train and a parallel data character. The serial data-train consists of a telemetry data word, its word and frame address, and a nine bit identification word. Thirty-seven bits make up the parallel-data character which consists of one or more telemetry words and parity bits.

The serial data are ultimately used to drive displays and recorders, while the parallel-data character output is available for entry into a computer when required.

Each data word selector (DWS) is a self-contained unit used to extract individual data words from the serial output of the synchronizer. Each data word selector contains three nine bit, programmable, pattern recognizers. The data word selector accepts serial input signals until the selected words are recognized, accepted and stored. By using multiple units set for the same recognition pattern, data words of greater than nine bits may be selected and stored.

Information from the data word selectors is displayed and/or recorded in three different ways: as an analog representation on an eight-channel chart recorder, as a decimal number displayed on a counter or as a third display on a bar-graph oscilloscope.

Data-Recording System

Data-recording is performed using a seven track, one-half inch magnetic tape recorder. It features modular, plug-in, solid state electronics which provide a high degree of operational flexibility. The tape transport accommodates either 10-1/2 inch or 14 inch diameter tape reels. With standard production machines, four tape speeds are available: 60, 30, 15 and 7-1/2 inches per second; however, the recorders on station have been modified to run at 3-3/4 and 1-7/8 inches per second as well. Later modification has increased the tape speed to 125 inches per second to provide a 500-kilocycle recording capability.

Strip chart graphic recording instruments are used which employ galvanometers driving hot wire styluses over plastic-coated paper. They serve as tracking data recorders in the Minitrack system, and are also used to record locally recovered telemetry data for "quick-look" purposes. A serial code readout of time from the station's digital clock is displayed in the margin of the chart.

A variety of auxiliary systems, too numerous to describe here, are used for antenna calibration and collimation, receiving system test and calibration and similar needs.

Control

Spacecraft operations control is a continuous and varied requirements when more than one type of spacecraft is in orbit at the same time. Accordingly, a central control area has been provided called the "Spacecraft Operations Facility."

The establishment of the Spacecraft Operations Facility at Goddard Space Flight Center in Greenbelt, Md., provides a central, integrated facility for the operation and control of space flights and provides supporting orbital computations and data processing and reduction services in connection with the experiments.

The central facility contains the following constituent elements:

1. An Operations Control Center containing facilities for the display and dissemination of information relative to the overall operations being conducted, and which acts to support the various operational projects.

2. Individual Project Operations Control Centers designed to the specific needs of a particular project.

3. An Intercommunication and Interdisplay System with the capability to handle the communication and data-flow to and from all support areas.

4. A Computational Facility to determine and predict the orbits of assigned space vehicles and disseminate these data in diverse forms.

5. A Data-Processing Center to process, store and disseminate scientific data in the form most suited to the needs of the experimenter.

6. A Communications Center which will provide data and voice links to and from stations of the network.

7. Ancillary facilities to sustain operational self-sufficiency on a 24-hour basis.

The Operations Control Center is the central point for effecting the coordination of all operational elements of the Goddard Tracking and data-systems: tracking, command, data-acquisition and data-transmission. This area maintains cognizance at all times of the status of the overall networks and related facilities. In this area, ultimate operational problems or conflicts are resolved. This is a function markedly distinct from those of the Project Operations Control Centers, wherein all information acquired and all control exercised is of specific relevance to a particular spacecraft project.

Information from and to the outlying Project Operations Control Centers is made available in the Operations Control Center by means of the closed-circuit television system which functions then as an extension of the intrinsic communications, display and data-system provided in the project centers as an integral part of the spacecraft project.

The Project Operations Control Centers are established, as needed, to centralize the operations and control support required for particular spacecraft projects. The staffing and equipment utilized varies from the very simple to the very complex, depending upon the support requirements.

Typical spacecraft requiring Project Operations Control Centers are application satellites, such as communication and meteorological satellites; observatory satellites, such as Orbiting Geophysical, Astronomical and Solar Observatories; a variety of Space Physics satellites; and lunar and planetary exploration satellites as well as manned flight spacecraft.

The Communications Center supporting the activities of the Spacecraft Operations Facility handles all traffic requirements of the network. The Communications Center encompasses a number of areas or sections functioning as follows:

1. Automatic Switching — This area contains equipment to perform automatic switching of digital transmissions (teletype, data, etc.), automatic circuit and facilities assurance, automatic routing selection, automatic traffic and outage analysis.

2. Station Conferencing and Monitoring Arrangement (SCAMA) — This system controls and monitors world-wide voice communications.

3. Data Terminal — Controls circuits used for audio bandwidth data transmissions, including facsimile transmissions.

4. Wideband Terminal — This area contains equipment required to control circuits used for video and wideband data transmission.

The Computing Center performs computational functions in support of both general orbit calculation programs and specific project missions. The general orbit calculations involve the determination and prediction of satellite orbital elements from which acquisition predictions are derived and issued to the tracking stations.

The objectives of the Data Processing Center are to provide rapid and accurate processing of the essential data with the minimum possibility of alteration or deletion of significant events. The ground processing system consists of four broad functions: editing and quick-look, conversion and formating, reduction, and analysis.

The translation of specific project requirements, through a versatile and flexible data-processing facility, to meaningful and useful results in finished form depends upon the effectiveness and availability of each element of this support. A variety of telemetry formats must be accommodated, as well as certain custom formats. This has led to the development of a Satellite Telemetry Automatic Reduction System (STARS) that is capable of handling any required format with significant improvement in speed and ease of operation. Twelve of these complete STARS systems are to be used in the Data Reduction Area.

Combining all of these capabilities, both at the ground stations and at the control area into a smooth functioning, multispacecraft support mechanism is the mission established to effectively utilize and obtain meaningful results from NASA's flight programs. This presentation is much too brief to detail the complexities of each area and only general information can be covered, but perhaps the basic outline of overall space flight program support can be visualized and understood from this effort.

The establishment, operation and maintenance of this program requires stations in ten foreign countries as well as the United States and involves over 1000 NASA employees, more than 700 contract employees and in excess of 300 foreign nationals. The efforts of these people have produced, and will continue to produce a truly international program of peaceful, scientific exploration of space.

APPENDIX D

PROJECT SUMMARY DATA

PART I

GODDARD SPACE FLIGHT CENTER SATELLITE AND SPACE PROBE PROJECTS

Designation	Objectives	LAUNCH AND ORBIT DATA: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	EXPERIMENT DATA: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
EXPLORER VI 1959 Delta 1 S-2	To measure three specific radiation levels of earth's radiation belts; test scanning equipment for earth's cloud cover; map earth's magnetic field; measure micrometeorites; study behavior of radiowaves.	Aug. 7, 1959 Oct. 6, 1959	Thor-Able ETR	12-1/2 hours	156	27,357	Dr. John C. Lindsay Dr. John C. Lindsay	Equipment to measure radiation levels; TV-type scanner; micro-meteorite detector; two types of magnetometers and devices for space communication experi-ments.	Triple coincidence telescopes – A	J. A. Simpson C. Y. Fan P. Meyer	U. of Chicago	Orbit achieved. All experiments performed. First complete televised cloud-cover picture was obtained. Detected large ring of electrical current circling earth; first detailed study of region now known as the Van Allen radiation belt.
									Scintillation counter – E	T.A. Farley Allen Rosen C.P. Sonnett	TRW/STL	
									Ionization chamber Geiger counter – E	J. Winckler	U. of Minnesota	
									Spin-coil magnetometer–E	E.J. Smith D.L. Judge	TRW/STL	
									Fluxgate magnetometer–E	P.J. Coleman	TRW/STL	Weight: 142 lb.
									Aspect sensor		TRW/STL	Power: Solar
									Image-scanning television system		TRW/STL	
									Micrometeorite detector–P		AFCRL	
											TWR/STL	
VANGUARD III 1959 Eta	To measure the earth's magnetic field, X-radiation from the sun, and several aspects of the space environment through which the satellite travels.	Sep. 18, 1959 Dec. 12, 1959	Vanguard ETR	130	319	2329		Proton precisional magnetometer, ionization chambers for solar X-rays, micrometeorite detectors and thermistors.	Proton magnetometer–E	J.P. Heppner	GSFC	Orbit achieved. Provided comprehensive survey of earth's magnetic field over area covered; surveyed location of lower edge of Van Allen radiation belt. Accurate count of micrometeorite impacts. Power: Solar
									Ionization chambers–E	H. Friedman	NRL	
									Environmental measurements	H.E. LaGow	GSFC	
EXPLORER VII 1959 Iota 1	Variety of experiments, including solar ultraviolet; X-ray; cosmic-ray; earth radiation, and micrometeor experiments.	Oct. 13, 1959 Aug. 24, 1961	Juno II ETR	101.33	342	680	H. E. LaGow	Sensors for measurements of earth-sun heat balance; Lyman-alpha and X-ray solar radiation detectors; micrometeorite detectors, Geiger-Mueller tubes for cosmic ray count; ionization chamber for heavy cosmic rays.	Thermal radiation balance	V. Suomi	U. of Wisconsin	Orbit achieved. Provided significant geophysical information on radiation and magnetic storms; demonstrated method of controlling internal temperatures; first micrometeorite penetration of a sensor in flight.
									Solar X-ray and Lyman-alpha–S	H. Friedman R.W. Kreplin T. Chubb	NRL	
									Heavy cosmic radiation–E	G. Groetzinger P. Schwed M. Pomerantz	Martin Co. Bartol Research	
									Radiation and solar-proton observation–E	J. Van Allen G. Ludwig H. Whelpley	St. U. of Iowa	Weight: 91.5 lb. Power: Solar
									Ground-based iono-proton observation – I	G. Swenson C. Little G. Reid O. Villard, Jr. W. Ross	U. of Illinois Nat. Bu. of Standards U. of Alaska Stanford U. Penn State U.	

ABBREVIATIONS:

AFCRL	Air Force Cambridge Research Lab.
ARC	Ames Research Center
BTL	Bell Telephone Labs.
CRPL	Central Radio Propagation Lab.
DRTE	Defense Research Telecommunications Establishment
DSIR	Department of Scientific and Industrial Research
ETR	Cape Kennedy
GSFC	Goddard Space Flight Center
JPL	Jet Propulsion Lab.
MIT	Massachusetts Institute of Technology
NRC	National Research Council
NRL	Naval Research Labs.
TRW/STL	Thompson-Ramo-Wooldridge/Space Technology Labs.
WTR	Vandenberg Air Force Base

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PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	EXPERIMENT DATA: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
EXPLORER VII (Continued)									Micrometeorite penetration–P	W. Dyke H. LaGow	Linfield Res. Inst. GSFC	
PIONEER V 1960 Alpha	To investigate interplanetary space between orbits of earth and Venus, test extreme long-range communications, study methods for measuring astronomical distances.	Mar. 11, 1960 June 26, 1960	Thor-Able ETR	311.6 days	Perihelion 74.9 million from sun	Aphelion 92.3 million from sun	Dr. John C. Lindsay Dr. John C. Lindsay	High-intensity radiation counter, ionization chamber Geiger-Mueller tube to measure plasmas, cosmic radiation, and charged solar particles. Magnetometer and micrometeorite temperature measurements.	Triple coincidence proportional counter cosmic-ray telescope–E Search-coil magnetometer and photo-electric cell aspect indicator–E Ionization chamber and G-M tube–E Micrometeorite counter–P	J. Simpson D. Judge J. Winckler E. Manring	U. of Chicago TRW/STL U. of Minnesota AFCRL	Highly successful exploration of interplanetary space between orbits of earth and Venus; established communication record of 22.5 million miles on June 26, 1960; made measurements of solar flare effects, particle energies and distribution, and magnetic-field phenomena in interplanetary space. Weight: 94.8 lb. Power: Solar
TIROS I Beta 1960 A-1	To test of experimental television techniques leading to eventual worldwide meteorological information system.	April 1, 1960 June 16, 1960	Thor-Able ETR	99.1	428.7	465.9	W. G. Stroud H. I. Butler	One wide and one narrow angle camera, each with tape recorder for remote operation. Picture data can be stored on tape or transmitted directly to ground stations.	TV camera systems (2)			Provided first global cloud-cover photographs (22,952 total) from near-circular orbit. Weight: 270 lb. Power: Solar
ECHO I 1960 Iota	To place 100-foot inflatable sphere into orbit; measure reflective characteristics of sphere and propagation; study effects of space environment.	Aug. 12, 1960 Passive satellite	Thor-Delta ETR	118.3	945	1049	R. J. Mackey	Two tracking beacons 107.94 Mc and 107.97 Mc.	Communications		JPL BTL NRL	Demonstrated use of radio reflector for global communications; numerous successful transmissions. Visible to the naked eye. Orbit characteristics perturbed by solar pressure due to high area-to-mass ratio. Still in orbit. Weight: 132 lb. (including inflation powder) Power: Passive
EXPLORER VIII 1960 XI S-30	To investigate the ionosphere by direct measurement of positive ion and electron composition; collect data on the frequency, momentum, and energy of micrometeorite	Nov. 3, 1960 Dec. 28, 1960	Juno II ETR	112.7	258	1423	Robert E. Bourdeau Robert E. Bourdeau	RF-impedance probe using a 20-foot dipole sensor; single-grid ion trap; four multiple-grid ion traps; Langmuir probe experiment, rotating shutter electric field meter; micro plier;	RF impedance–I Ion traps–I	J. Cain R. Bourdeau G. Serbu E. Whipple J. Donley	GSFC GSFC	The micrometeorite influx rate was measured. Weight: 90.14 lb. Power: Battery

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PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Perigee (Statute Miles)	Apogee (Statute Miles)	Project Manager and Project Scientist	Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
EXPLORER VIII (Continued)	impacts; establish the attitude of the base of the exo-sphere.							micrometeorite micro-phone; thermistors for reading internal and surface temperatures of the spacecraft, and de-spin mechanisms to reduce spin from 450 to to 30 rpm.	Langmuir probe–I Rotating-shutter elec-tric field meter–I Micrometeorite photomultiplier–I Micrometeorite microphone–I	R. Bourdeau G. Serbu E. Whipple J. Donley J. Donley M. Alexander C. McCracken O. Berg M. Alexander C. McCracken	GSFC GSFC GSFC GSFC	
TIROS II 1960 Pi I A-2	To test experimental television techniques and infrared equip-ment leading to even-tual world-wide meteorological in-formation system.	Nov. 23, 1960 July 12, 1961	Delta ETR	98.2	406	431	Dr. R. A. Stampfl	Included one wide-angle and one narrow-angle camera, each with tape recorder for remote operation; infrared sensors to map radia-tion in various spectral bands; attitude sensors; experimental magnetic orientation control.	Two TV camera systems Widefield radiometer Scanning radiometer	W. Nordberg R. Hanel	GSFC GSFC	Orbit achieved. Narrow-angle camera and IR in-strumentation sent good data. Trans-mitted 36,156 pic-tures. Still opera-tive. Weight: 277 lb. Power: Solar
EXPLORER IX 1961 Delta I S-56a (A project of the Langley Research Center with GSFC participation)	To study performance, structural integrity, and environmental conditions of Scout research vehicle and guidance controls system. Inject in-flatable sphere into earth orbit to deter-mine density of atmosphere.	Feb. 16, 1961 Passive Satellite	Scout Wallops Island	118.3	395	1605		Radio beacon on bal-loon and in fourth stage.				Vehicle functioned as planned. Balloon and fourth stage achieved orbit. Transmitter on bal-loon failed to func-tion properly requir-ing optical tracking of balloon. Weight: 80 lb. Power: Passive
EXPLORER X 1961 Kappa P-14	To gather definite in-formation on earth and interplanetary mag-netic fields and the way these fields ef-fect and are affected by solar plasma.	March 25, 1961 March 27, 1961	Thor-Delta ETR	112 hours	100	186,000	Dr. J. P. Heppner Dr. J. P. Heppner	Included rubidium vapor magnetometer, two flux-gate mag-netometers, a plasma probe, and an optical aspect sensor.	Rubidium-vapor mag-netometer and flux-gate magnetometers – E Plasma probe–E Spacecraft attitude	J. P. Heppner T. L. Skillman C. S. Scearce H. Bridge F. Scherb B. Rossi J. Albus	GSFC MIT GSFC	Probe transmitted valuable data con-tinuously for 52 hours as planned. Demonstrated the existence of a geo-magnetic cavity in the solar wind and the existence of solar proton streams transporting solar interplanetary mag-netic fields past the earth's orbit. Weight: 79 lb. Power: Battery

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Designation	Objectives	LAUNCH AND ORBIT DATA: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	EXPERIMENT DATA: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
EXPLORER XI 1961 Nu 1 S-15	To orbit a gamma-ray astronomy telescope satellite to detect high-energy gamma rays from cosmic sources and map their distribution in the sky.	April 27, 1961 Dec. 6, 1961	Juno II ETR	108.1	308	1113.2	Dr. J. Kupperian, Jr. Dr. J. Kupperian, Jr.	Gamma-ray telescope consisting of a plastic scintillator, crystal layers, and a Cerenkov detector; sun and earth sensors; micrometeorite shields; temperature sensor; damping mechanism.	Gamma-ray telescope—E	W. Kraushaar G. Clark	MIT	Orbit achieved. Detected first gamma rays from space. Directional flux obtained. Disproved one part of "steady-state" evolution theory. Weight: 82 lb. Power: Solar
TIROS III 1961 Rho 1 A-3	To develop satellite weather observation system; obtain photos of earth's cloud cover for weather analysis; determine amount of solar energy absorbed, reflected and emitted by the earth.	July 12, 1961 Feb. 1962	Delta ETR	100.4	461.02	506.44	Robert Rados	Two wide-angle cameras, two tape recorders and electronic clocks, infrared sensors, five transmitters, attitude sensors, magnetic attitude coil.	Omnidirectional radiometer Widefield radiometer Scanning radiometer Two TV Cameras	V. Suomi R. Hanel W. Nordberg	U. of Wisconsin GSFC GSFC	Orbit achieved. Cameras and IR instrumentation transmitted good data. Transmitted 35,033 pictures. Weight: 285 lb. Power: Solar
EXPLORER XII ENERGETIC PARTICLES EXPLORER 1961 Upsilon 1	To investigate solar wind, interplanetary magnetic fields, distant portions of earth's magnetic field, energetic particles in interplanetary space and in the Van Allen belts.	Aug. 15, 1961 Dec. 6, 1961	Thor-Delta ETR	26.45 hours	180	47,800	Paul Butler Dr. F. B. McDonald	Ten particle detection systems for measurement of protons and electrons and three orthogonally mounted fluxgate sensors for correlation with the magnetic fields, optical aspect sensor, and one transmitter. PFM telemetry transmitting continuously.	Two mass spectrometers—P Four vacuum (pressure) gauges—P Two electrostatic probes—I	C. Reber R. Horowitz G. Newton N. Spencer L. Brace	GSFC GSFC GSFC	Orbit achieved. All instrumentation operated normally. Ceased transmitting on Dec. 6, 1961, after sending 2568 hours of real-time data. Provided significant geophysical data on radiation and magnetic fields. Weight: 83 lb. Power: Solar
EXPLORER XIII 1961 Chi 1 (A project of the Langley Research Center with GSFC participation)	To test performance of the vehicle and guidance; to investigate nature and effects on space flight of micrometeoroids.	Aug. 25, 1961 Aug. 27, 1961	Scout Wallops Island	97.5	74	722	C. T. D'Aiutolo	Micrometeorids impact detectors; transmitters.	Cadmium sulphide photoconductor—A Wire Grid	M. W. Alexander L. Secretan	GSFC	Orbit was lower than planned. Reentered August 27, 1961. Weight: 187 lb. including 50-lb. 4th stage and 12-lb. transition section. Power: Solar
P-21 ELECTRON DENSITY PROFILE PROBE P-21	To measure electron densities and to investigate radio propagation at 12.3 and 73.6 Mc under daytime conditions.	Oct. 19, 1961 Oct. 19, 1961	Scout Wallops Island				John E. Jackson Dr. S. J. Bauer	Continuous-wave propagation experiment for the ascent portion of the trajectory, and an RF-probe technique for the descent.	RF probe—I CW propagation —I	H. Whale G. H. Spaid J. E. Jackson	GSFC GSFC GSFC	Probe achieved altitude of 4261 miles and transmitted good data. Electron density was obtained to about 1500 miles, the first time such measurements had been taken at this altitude.

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S – Solar Physics

PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
		Launch Date / Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles Perigee	Statute Miles Apogee		Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
P-21 (Continued)												Weight: 94 lb. Power: Battery
TIROS IV 1962 Beta A-9	To develop principles of a weather satellite system; obtain cloud and radiation data for use in meteorology.	Feb. 8, 1962 June 19, 1962	Delta ETR	100.4	471	525	Robert Rados	Two TV camera systems with clocks and recorders for remote pictures, infrared sensors, heat budget sensors, magnetic orientation control horizon sensor, north indicator.	Omnidirectional radiometer Widefield radiometer Scanning radiometer Two TV camera systems	V. Suomi R. Hanel W. Nordberg	U. of Wisconsin GSFC GSFC	Orbit achieved. All systems operated properly. Tegea Kinoptic lens used on one camera, Elgeet lens on the other. Supported Project Mercury. Weight: 285 lb. Power: Solar
ORBITING SOLAR OBSERVATORY 1962 Zeta OSO-1	To measure solar electromagnetic radiation in the ultra-violet, X-ray and gamma-ray regions; to investigate effect of dust particles on surfaces of spacecraft.	March 7, 1962 Aug. 6, 1963	Delta ETR	96.15	343.5	369	Dr. John C. Lindsay Dr. John C. Lindsay	Devices to conduct 13 different experiments for study of solar electro-magnetic radiations; investigate dust particles in space and thermoradiation characteristics of spacecraft surface materials.	X-ray spectrometer–S 0.510 Mev gamma-ray monitoring; 20-100 kev X-ray monitoring; 1-8A X-ray monitoring–S Dust particle–E Solar radiation and solar ultraviolet–A Solar gamma rays, high-energy distribution–A Solar gamma rays, low-energy distribution–A Solar gamma rays, high-energy distribution–A Neutron monitor–E Lower Van Allen belt–E Emissivity stability of surfaces in a vacuum environment–E	W. Behring W. Neupert K. Frost W. White M. Alexander C. McCracken W. White K. Hallam W. White K. Frost J. R. Winkler L. Peterson M. Savedoff G. Fazio W. Hess S. Bloom G. Robinson	GSFC GSFC GSFC GSFC GSFC U. of Minnesota U. of Rochester U. of California U. of California ARC	Orbit achieved. Experiments transmitted as programmed. Weight: 458 lb. Power: Solar
P21A ELECTRON DENSITY PROFILE PROBE	To measure electron density profile, ion density, and intensity of ions in the atmosphere.	March 29, 1962 March 29, 1962	Scout Wallops Island				John E. Jackson Dr. S. J. Bauer	A continuous-wave propagation experiment to determine electron density and associated parameters of ionosphere. A swept-frequency probe for direct measurements of electron density and a positive ion experiment to determine ion concentration under night-time conditions.	CW propagation–I RF probe–I Ion traps–I	S. Bauer H. White R. Bourdeau E. Whipple J. Donley G. Serbu	GSFC GSFC GSFC	Probe achieved altitude of 3910 miles. Afforded nighttime observations. Determined that characteristics of the ionosphere differ drastically from daytime state when the temperature of the ionosphere is much cooler. (See P-21) Weight: 94 lb. Power: Battery

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PART I

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Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
ARIEL 1 INTERNATIONAL SATELLITE 1962 Omicron 1 (UK-1)	To study the relationships between ionosphere and cosmic rays.	April 26, 1962 Active (see remarks)	Delta ETR	100.9	242.1	754.2	R. C. Baumann Robert E. Bourdeau	Electron density sensor, electron temperature gauge, solar aspect sensor, cosmic-ray detector, ion mass sphere, Lyman-alpha gauges, tape recorder, X-ray sensors.	Electron density sensor–I Electron temperature gauge–I Cosmic-ray detector–E Ion mass sphere–I Lyman-alpha gauge–I X-ray emission–I	J. Sayers R. L. F. Boyd H. Elliot R.L.F. Boyd R.L.F. Boyd R.L.F. Boyd	U. of Birmingham, (U.K.) U. College, London (U.K.) Imperial College, London (U.K.) U. College, London (U.K.) U. College London (U.K.) U. College, London (U.K.)	Orbit achieved. First international satellite. Contained six British experiments launched by American Delta vehicle. All experiments except Lyman-alpha transmitted as programmed. Lyman-alpha gauge failed during launch, ion mass sphere, Sept. 1962; X-ray emission, Oct. 1962; cosmic-ray detector, Dec. 1962, and electron density sensor, Mar. 1963. Tracking and data acquisition stopped on request of the project on June 30, 1964. Restarted on Aug. 25, 1964 for a 2-month period. Good data is being acquired from electron temperature gauge.
TIROS V 1962 Alpha Alpha 1 A-50	To develop principles of a weather satellite system; obtain cloud-cover data for use in meteorology.	July 19, 1962 May 4, 1963	Delta ETR	100.5	367	604	Robert Rados	Two TV camera systems with tape recorders for recording remote picture areas, magnetic orientation control, horizon sensor, north indicator.	Two TV camera systems			Launched at a higher inclination (58°) than previous TIROS satellites, to provide greater coverage. Time of launch chosen to include normal hurricane season for South Atlantic. One TV system transmitted good data for 10-1/2 months. Weight: 285 lb. Power: Solar
TELSTAR NO. 1 (A project of AT&T) 1962 Alpha Epsilon 1	Joint AT&T-NASA investigation of wideband communications.	July 10, 1962 Feb. 21, 1963	Delta ETR	157.8	592.6	3503.2	C. P. Smith, Jr.	The system provided TV, radio, telephone and data transmission via a satellite repeater system.	Included electron detector for range 250,000-1 Mev; proton detectors in the following energy ranges 2.5–25.0 Mev, ranges greater than 50 Mev.	W. Brown	BTL	Orbit achieved. Television and voice transmissions were made with complete success. BTL provided spacecraft and ground stations facilities. Government was reimbursed for cost incurred. Conducted more than 300 technical tests and over 400

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PART I

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Designation	Objectives	Launch and Orbit Data: Launch Date/ Silent Date	Launch and Orbit Data: Vehicle & Launch Site	Launch and Orbit Data: Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	Experiment Data: Instrumentation Summary	Experiment Data: Experiment and Discipline*	Experiment Data: Experimenter	Experiment Data: Affiliation	Remarks
TELSTAR NO. 1 (Continued)												demonstrations; 50 TV programs–5 in color. Weight: 175 lb. Power: Solar
TIROS VI 1962 Alpha Psi 1 A-51	To study cloud cover and earth heat balance; measurement of radiation in selected spectral regions as part of a program to develop meteorological satellite systems.	Sept. 18, 1962 Oct. 11, 1963	Delta ETR	98.73	425	442	Robert Rados	Two TV camera systems (78° and 104° lens), clocks and tape recorders for remote operation, infrared and attitude sensors, magnetic-attitude coil.	Two TV camera systems			Inclination 58.3°; velocity at perigee 16,822; apogee, 16.756. Medium-angle camera failed Dec. 1, 1962 after taking 1074 pictures. TV camera provided good data for 13 months after launch. Weight: 300 lb. Power: Solar
ALOUETTE I SWEPT FREQUENCY TOPSIDE SOUNDER (Canada) 1962 Beta Alpha 1	To measure the electron density distribution in the ionosphere between the satellite height (620 miles) and the F2 peak (approx. 180 miles) and to study for a period of 1 year the variations of electron density distribution with time of day and with latitude under varying magnetic and auroral conditions with particular emphasis on high-latitude effects. To obtain galactic-noise measurements, study the flux of energetic particles, and investigate whistlers.	Sept. 29, 1962	Thor-Agena WTR	105.4	620	638	John E. Jackson	The satellite was spin-stabilized and contained a swept-frequency pulse sounder covering the frequency range 0.5 to 11.5 Mc. Sounder data was transmitted via a 2-watt FM telemetry system. Data from the other experiments and housekeeping data was transmitted through a 1/4-watt PM-telemetry system. There were two sets of sounder antennas, the longest set measuring 150 ft. tip to tip. Data was acquired on command and in real time only.	Topside sounder–I Energetic particle counters–E VLF receiver (whistler)–I Cosmic noise–A	E.S. Warren G.L.B. Nelms G.E. Lockwood E.L. Hagg L.E. Petrie D.B. Muldrew R.W. Knecht T.E. Van Zandt W. Calvert J.W. King S.J. Bauer L. Blumle R. Fitzenreiter J.E. Jackson D.C. Rose I.B. McDiarmid J.S. Belrose T.K. Hartz	DRTE CRPL NBS DSIR England GSFC NRC Canada DRTE DRTE	The Alouette satellite is a project of the Canadian Defence Research Board. This international project is a part of NASA's topside sounder program and was the first NASA-launched satellite from the WTR. Alouette has the distinction of being the first spacecraft designed and built by any country other than the U.S. and the USSR. Weight: 320 lb. Power: Solar
EXPLORER XIV ENERGETIC PARTICLES SATELLITE 1962 Beta Gamma 1 EPE-B	To correlate energetic particles activity with observations of the earth's magnetic fields; to monitor the existence of transient magnetic fields associated with plasma streams.	Oct. 2, 1962 Feb. 1964	Delta ETR	36.58 hours	184	54,123	Paul G. Marcotte Dr. F.B. McDonald	A low-energy (0.1 to 20 kev) proton analyzer; a three-core magnetometer; one omnidirectional and three directional electron-proton detectors; a three-basic unit cosmic-ray package; an ion-electron scintillation detector; and devices to determine the	Proton analyzer–E Magnetic field (magnetometer)–E Trapped-particle radiation–E Cosmic-ray, ion-electron detector, solar-cell, and electrolytic timer–E	M. Bader L. Cahill J.A. Van Allen B.J. O'Brien F.B. McDonald L.R. Davis U. Desai	ARC U. of New Hampshire State U. of Iowa GSFC	Velocity at apogee 1507 mph; perigee 23,734 mph. Inclination to equator 33°. Weight: 89.25 lb. Power: Solar

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PART I
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Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
EXPLORER XIV (Continued)								effects of radiation on solar cells and the effects of space on electrolytic timers.				
EXPLORER XV	To study artificial radiation belt created by nuclear explosion.	Oct. 27, 1962 Feb. 9, 1963	Delta ETR	5 hours (C. 315 min.)	195	10,950	Dr. John W. Townsend Dr. Wilmot Hess	Similar to Explorer XII	Electron energy distribution–I Omnidirectional detector–I Angular distributor–E Directional detector–I Ion-electron detector–E Magnetic field–E Solar cell damage–I	W. Brown U. Desai C. McIlwain W. Brown C. McIlwain L. Davis L. Cahill H. K. Gummel	BTL GSFC U. of California BTL U. of California GSFC U. of New Hampshire BTL	Good data received on artificial radiation belt. Weight: 100 lb. Power: Solar
RELAY I 1962 B Upsilon 1	To investigate wideband communications between ground stations by means of low-altitude orbiting spacecraft, Communications signal to be evaluated will be an assortment of TV signals, multichannel telephony, and other communications. To measure the effects of the space environment on the system; to include radiation damage to solar cells and radiation flux density. To provide tests and demonstrations of low-altitude communications satellite.	Dec. 13, 1962	Delta ETR	185.09	819.64	4612.18	Wendell Sunderlin Dr. Ramond Waddel	The spacecraft contained an active communications repeater to receive and retransmit communications between the U.S. and Europe, U.S. and South America, U.S. and Japan, and Europe and South America; and an experiment to assess radiation damage to solar cells, and to measure proton and electron energy.	Determine radiation damage to solar cells and semiconductor diodes–E Measure proton energy (2.5-25.0 Mev)–E Measure electron energy (1.25-2.0 Mev)–E Measure integral omnidirectional proton flux energy (35.0-300.0 Mev)–E Measure directional electron energy (0.5-1.2 Mev)–E Measure directional proton energy (15.0-60.0 Mev)–E Measure directional proton energy (1.0-8.0 Mev)–E	R. Waddel W. Brown W. Brown C. McIlwain C. McIlwain C. McIlwain C. McIlwain	GSFC BTL BTL U. of California U. of California U. of California U. of California	Orbit achieved. TV, telephone, teletype, facsimile, and digital-data transmissions were made with very satisfactory results. Conducted more than 2000 technical tests and 172 successful demonstrations. Weight: 172 lb. Power: Solar
SYNCOM I 1963 4A A-25	To provide experience in using communications satellites in a 24-hour orbit. To flight-test a new, simple approach to satellite attitude and period control. To develop transportable ground facilities to be used in conjunction with communications satellites. To develop capability of launching satellites.	Feb. 14, 1963 Feb. 14, 1963	Delta ETR	24 hours	Near-synchronous orbit	22,300	R. J. Darcey	The 24-hour communications satellite consists of a spin-stabilized active repeater in a near-synchronous low-inclination orbit. The spacecraft is in the form of a cylinder 28 inches in diameter and 15 inches high. The repeater consists of a 7200-Mc receiver and an 1800-Mc transmitter with an output of 2 watts. In addition, the spacecraft contains				Twenty seconds after firing apogee rocket, all satellite transmissions stopped. The satellite was sighted on Feb. 28, 1963 and later dates. It was traveling in a near-synchronous orbit eastward at about 2.8° per day. Weight: 78 lb. Power: Solar

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Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
SYNCOM I (Continued)	into 24-hour orbit using existing vehicles, plus apogee kick techniques and to test components life at 24-hour-orbit altitude.							a vernier velocity control system for orientation of spin axis and adjustment of the orbit.				
EXPLORER XVII ATMOSPHERE EXPLORER 1963 9A	To measure the density, composition, pressure, and temperature of the earth's atmosphere from 135 to 540 nautical miles and to determine the variations of these parameters with time of day, latitude, and in part, season.	April 2, 1963 July 10, 1963	Delta ETR	96.4	158.1	598.5	N. W. Spencer	Primary detectors to be employed (two each) are: Double focusing magnetic sector mass spectrometer, hot-cathode total-pressure ionization gauges and cold-cathode total-pressure ionization gauges. The remaining satellite instrumentation converts the outputs from six detectors to radio signals.	Two mass spectrometers—P Four vacuum (pressure) gauges—P Two electrostatic probes—I	C. Reber R. Horowitz G. Newton N. Spencer L. Brace	GSFC GSFC GSFC GSFC	Confirmed that the earth is surrounded by a belt of neutral helium at an altitude of from 150 to 600 miles. Weight: 405 lb. Power: Silver zinc batteries
TELSTAR II 1963 13A (A project of AT&T)	Joint AT&T-NASA investigation of wideband communications.	May 7, 1963	Delta ETR	221	575	6559	C. P. Smith, Jr.	The system provides for TV, radio, telephone and data transmission via a satellite repeater system.	Included electron detector for energy range 750,000 to 2 Mev			"Evacuated" transistors in one of the encoders. Weight: 175 lb. Power: Solar
TIROS VII 1963 24A	To launch into orbit a satellite capable of viewing cloud cover, and the earth's surface and atmosphere by means of television cameras and radiation sensors. To acquire and process collected data from satellite and to control its attitude by magnetic means.	June 19, 1963	Delta ETR	97.4	385.02	401.14	Robert Rados	Two vidicon cameras each with a wide-angle lens, five-channel medium-resolution radiometer, electron temperature probe, and magnetic attitude coil.	Omnidirectional radiometer—P Scanning radiometer Electron temperature experiment—R	V. Suomi A. McCulloch N. Spencer	U. of Wisconsin GSFC GSFC	TV coverage extended to 65°N and 65°S latitudes. Launch date selected to provide maximum northern hemisphere coverage during 1963 hurricane season. Electron temperature probe malfunction 26 days after launch. First TIROS to have two operational camera systems and fully functioning IR subsystem 15 months after launch. Weight: 297 lb. Power: Solar Inclination: 58° to equator
SYNCOM II 1963 31A A-26	To provide experience in using communications satellites in a 24-hour orbit. To flight-test a new, simple approach to satellite attitude and period control. To	July 26, 1963	Delta ETR	24 hours	22,300 near-synchronous orbit		R. J. Darcey	The 24-hour communications satellite consists of a spin-stabilized active repeater in a near-synchronous low-inclination orbit. The spacecraft is in the form of a cylinder 28 inches				Orbit and attitude control of the spin-stabilized synchronous satellite achieved. Data telephone, and facsimile transmission were excellent.

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		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
SYNCOM II (Continued)	develop transportable ground facilities to be used in conjunction with communications satellites. To develop capability of launching satellites into 24-hour orbit using existing vehicles, plus apogee kick techniques and to test components life at 24-hour orbit altitude.							in diameter and 15 inches high. The repeater consists of a 7200-Mc receiver and an 1800-Mc transmitter with an output of 2 watts. In addition, the spacecraft contains a vernier velocity-control system for orientation of spin axis and adjustment of the orbit.				Television video signals also were successfully transmitted, even though the satellite was not designed for this capability. Weight: 70 lb. Power: Solar
EXPLORER XVIII INTERPLANETARY EXPLORER PLATFORM 1963 46A (IMP)	To study in detail the radiation environment of cislunar space and to monitor this region over a significant portion of a solar cycle. To study the quiescent properties of the interplanetary magnetic field and its dynamical relationships with particle fluxes from the sun. To develop a solar flare prediction capability for Apollo. To extend the knowledge of solar-terrestrial relationships. To further the development of simple, inexpensive, spin-stabilized spacecraft for interplanetary investigations.	Nov. 27, 1963	Delta ETR	93 hours	122	121,605	Paul Butler Dr. F. B. McDonald	To carry 10 experiments; essentially a combination of the successful GSFC Explorer X and XII satellites. It is spin-stabilized and powered by solar cells. The system is designed so that data can be received from apogee by the GSFC Minitrack stations.	Plasma-measure thermal ions and electrons 0.10 ev–I Magnetic field experiment (fluxgate magnetometer)–E Measure solar and galactic protons and alpha particles–E Measure total ionization produced per unit time in a unit volume of standard density air–E Measure flux of low-energy interplanetary plasma–E Measure solar and galactic protons, electrons, alpha particles, heavy primaries, and isotropy of solar proton events and of cosmic-ray modulation–E Magnetic field (rubidium-vapor magnetometer)–E Solar wind proton concentrations–E	G. P. Serbu R. Bourdeau N. F. Ness J. A. Simpson K. A. Anderson H. S. Bridge F. McDonald G. Ludwig N. F. Ness John Wolfe	GSFC GSFC U. of Chicago U. of California MIT GSFC GSFC ARC	All experiments and equipment operating satisfactorily except for thermal ion experiment which is giving only 10 percent good data. Continues to provide significant data since launch. First accurate measure of the interplanetary magnetic field, and the shock front. First satellite to survive a severe earth shadow of 7 hr., 55 min. Electronics equipment estimated to have cooled to below -60°C. Weight: 137.5 lb. Power: 38 watts solar
TIROS VIII 1963 54A	To launch into orbit a satellite capable of viewing cloud cover and the earth's atmosphere by means of television cameras. To acquire and process collected data from satellite and to control its attitude by magnetic means.	Dec. 21, 1963	Delta ETR	99.35	435.01	468.30	Robert Rados	One standard TIROS vidicon with a wide-angle lens camera system, and one automatic picture transmission camera system; magnetic attitude coil.				This satellite proved for the first time the feasibility of APT (automatic picture transmission) an inexpensive direct facsimile readout. Weight: 265 lb. Power: Solar

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Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee		Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
RELAY II 1964 3A	To investigate wideband communications between ground stations by means of low-altitude orbiting spacecraft. Communications signal to be evaluated will be an assortment of TV signals, multichannel telephony, and other communications. To measure also the effects of the space environment on the system; to include radiation damage to solar cells and radiation flux density. To provide tests and demonstration of low-altitude communications satellite.	Jan. 21, 1964	Delta ETR	194.7	1298	4606	Wendell Sunderlin Dr. Ramond Waddel	The spacecraft contains an active communications repeater to receive and retransmit communications between the U.S. and Europe, U.S. and South America, U.S. and Japan, and Europe and South America; and on experiment to assess radiation damage to solar cells, and to measure proton and electron energy.	Determine radiation damage to solar cells and semiconductor diodes–E	R. Waddel	GSFC	Orbit achieved. TV, telephone, teletype facsimile, and digital-data transmissions were made with very satisfactory results. Conducted more than 1500 technical tests and 95 successful demonstrations. Weight: 184 lb. Power: Solar
									Measure proton energy (2.5-25.0 Mev)–E	W. Brown	BTL	
									Measure electron energy (0.6-1.6 Mev)–E	W. Brown	BTL	
									Measure integral omnidirectional proton flux energy (40.0-300.0 Mev and electrons greater than 5 Mev)–E	C. McIlwain	U. of California	
									Measure directional electron energy (0.4-1.2 Mev)–E	C. McIlwain	U. of California	
									Measure directional proton energy (18.0-60.0 Mev)–E	C. McIlwain	U. of California	
									Measure directional proton energy (1.0-8.0 Mev)–E	C. McIlwain	U. of California	
ECHO II Passive Communications Satellite (Rigidized sphere) 1964 4A	To demonstrate a spacecraft deployment and rigidization technique applicable to passive-communications satellites; to advance the state-of-the-art represented by the presently orbiting Echo I satellite; to provide development directly applicable to the accomplishment of the Advanced Passive Communications Satellite Program; to constitute a step toward the development of the technology necessary for establishment of a global passive communications network for civilian use.	Jan. 25, 1964	Thor-Agena B WTR	109	557.9	709.1	Herbert L. Eaker	Two beacon transmitters	Communications Propagation Acquisition and tracking Radar Optical	U.S. Air Force, U.S. Navy United Kingdom Soviet Union, Ohio State University		Weight: 650 lb. Power: Solar Inclination: 82°
BEACON EXPLORER BE-A	To study for a minimum period of 1 year the variations of electron density distribution as a function of latitude, and seasonal and diurnal time, under varying magnetic and solar conditions.	Mar. 19, 1964 Mar. 19, 1964	Delta ETR	Note Remarks			Frank T. Martin Robert E. Bourdeau	Four coherent, ultra-stable, unmodulated CW transmitters (operating at 20, 40, 41, and 360 Mc) radiate signals from dipole antennas for reception by a worldwide network of over 100 observing stations.	Measurement of electron content–I	Frank T. Martin	U. of Illinois	Observing Stations; Stations operated by prime experimenters: a. University of Illinois: Urbana, Illinois; Houghton, Michigan; Baker Lake, Canada; Adak, Alaska
									Absorption scintillation–I	Robert E. Bourdeau	Pennsylvania State U. NBS Stanford U. and international participants	

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PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

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BE-A (Continued)												b. Pennsylvania State U. University Park, Pennsylvania Huancayo, Peru c. Stanford University: Stanford, California Honolulu, Hawaii; Macapa, Brazil; Guarapes, Brazil; S.J. dos Campos Brazil; Santiago, Chile; Ushuaia, Argentina d. Central Radio Propagation Laboratory (NBS): Boulder, Colorado; 2 mobile stations within 100-mile radius of Boulder, Colorado International Participation: More than 100 international observing ground stations participated in the program. Doppler tracking data both from Antigua and Brazil tracking stations indicated that the satellite did not achieve orbital velocity. The satellite re-entered the earth's atmosphere over the South Atlantic coast of Argentina and disintegrated. This was the first Delta vehicle failure in 23 launch attempts. Weight: 172 lb.
ARIEL II INTERNATIONAL SATELLITE 1964 15A	To continue U.S. – U.K. cooperative satellite program. This is second phase of a three-satellite program. The satellite mission is to make scientific measurements using the	Mar. 27, 1964	Scout Wallops Island	102	180	840	Emil Hymowitz Lawrence Dunkelman	Ariel II is designed to perform three experiments: the galactic-noise experiment to record galactic noise in the 0.75- to 3.0-Mc region and to explore the ionosphere; the ozone	Measurement of galactic radio noise in the 0.75 to 3.0-Mc frequency range—I Measure vertical distribution of atmospheric ozone—P	F. G. Smith K. H. Stewart	U. of Cambridge (U.K.) Air Ministry (U.K.)	This satellite is a cooperative U.S.-U.K. effort. The U.K. was responsible for all flight instrumentation pertaining to the experiments and for

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I – Ionospheric Physics
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P – Planetary Atmospheres
S – Solar Physics

PART I

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ARIEL II (Continued)	U.K.-furnished experiments.							experiment to measure the vertical distribution of ozone in the earth's atmosphere; and the micrometeorite experiment to obtain quantitative measurements of particle flux.	Measurement of the micrometeroid flux–A	R.C. Jennison	U. of Manchester-Jodrell Bank (U.K.)	data-reduction analysis. The U.S. was responsible for the design, fabrication, and testing of the prototype-flight spacecraft and all subsystems, except for the experiment requirements. Tracking and data acquisition are joint responsibility. Inclination: 52° Power: Solar
SYNCOM III 1964 47A A-27	To provide experience in using communications satellites in a 24-hour near-equatorial orbit. To flight-test a new, simple approach to satellite attitude and period control. To develop transportable ground facilities to be used in conjunction with communications satellites. To develop capability of launching satellites into 24-hour near-equatorial orbit using existing vehicles plus apogee-kick techniques and to test components life at 24-hour orbit altitude.	Aug. 19, 1964	Thrust-augmented Delta ETR		22,300 synchronous orbit		R. J. Darcey	The 24-hour communications satellite consists of a spin-stabilized active repeater in a near-synchronous low-inclination orbit. The spacecraft is in the form of a cylinder, 28 inches in diameter and 15 inches high. The repeater consists of a 7200-Mc receiver and an 1800-Mc transmitter with an output of 2 watts. In addition, the spacecraft contains a vernier velocity-control system for orientation of spin axis and adjustment of the orbit.				Orbit and attitude control of the spin-stabilized satellite into near-equatorial synchronous orbit achieved. Data, telephone, and facsimile transmissions were excellent. Television video signals were successfully transmitted through the wideband (13-Mc) transponder. Weight: 70 lb. Power: Solar
EXPLORER XX IE-A 1964 51A	To measure the electron density distribution in space and time between the height of the maximum electron density in the F2 region (approximately 180 miles) and the height of the satellite (620 miles) including the geometry and number of irregularities. To determine the ion and electron densities and temperatures in the vicinity of the satellite and to estimate cosmic noise in the 2- to 7-Mc frequency range.	Aug. 25, 1964	Scout WTR	104	538	628	E. Dale Nelsen	Six ionosphere explorers from 1.50- to 7.22 Mc and an ion mass spectrometer (U.K.). The longest set of sounding antenna will measure 122 feet, tip to tip. Scientific data will be transmitted via a 2-watt FM telemetry system; upon command, data acquired in real time only. Housekeeping data acquired from a 1/4-watt PM telemetry transmitter.	Fixed-frequency sounder–I Ion probe–I	R. Knecht R.L.F. Boyd A.P. Willmore	CRPL/NBS U. College, London	26 inches in diameter and 32-1/2 inches high; 2400 solar cells mounted round side of satellite. Weight: 97.9 lb. Power: Solar

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E – Energetic Particles and Fields
I – Ionospheric Physics
A – Astronomy
P – Planetary Atmospheres
S – Solar Physics

PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA: Launch Date/ Silent Date	LAUNCH AND ORBIT DATA: Vehicle & Launch Site	LAUNCH AND ORBIT DATA: Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	EXPERIMENT DATA: Instrumentation Summary	EXPERIMENT DATA: Experiment and Discipline*	EXPERIMENT DATA: Experimenter	EXPERIMENT DATA: Affiliation	Remarks
NIMBUS 1	To provide a large amply powered earth-stabilized spacecraft and tests of a variety of sensors for atmospheric research coupled with a ground data-handling system to acquire and process atmospheric data in real time.	Aug. 28, 1964 Sept. 23, 1964	Thor-Agena B WTR	98.7	263	579	Harry Press William Nordberg	Television cameras to photograph earth's cloud cover; equipment for infrared radiation measurements. Two large paddles of solar cells convert the sun's energy into electric power. Spacecraft also has tape recorders. PCM telemetry, and 128 coded commands.	Advanced vidicon camera system	G. Burdett	GSFC	Due to premature burnout of Thor-Agena second stage, the spacecraft was launched into a highly elliptical orbit instead of the intended 550-mile circular orbit. Weight: 830 lb.
									Automatic picture transmission system	G. Hunter	GSFC	
									High-resolution infrared radiometer	L. Foshee	GSFC	
ORBITING GEOPHYSICAL OBSERVATORY OGO-I 1964 54A	To launch and operate an orbital spacecraft carrying experiments to make scientific geophysical measurements about the earth.	Sept. 4, 1964	Atlas-Agena B ETR	63.983 hr.	175	92,827	Wilfred E. Scull Dr. G. H. Ludwig	The first in a series of standarized "street" car" satellites. The concept envisions a basic scientific spacecraft, capable of accommodating as many as 30 different experiments.	Triaxial search-coil magnetometer–E	E. J. Smith R. E. Holzer	JPL UCLA	Performance of the Atlas-Agena launch rocket was normal. However, shortly after separation from the Agena second stage it appeared that the mission might be in jeopardy because of nondeployment of two booms. This resulted in abnormal operation of the automatic control system to lock the spacecraft into its earth-stabilized orbit. The inability to lock on the earth was later attributed to the fact that the satellite's earth-seeking sensor was obscured by one of the undeployed booms. About 4-1/2 hours after launch, OGO I was commanded into a "hold" condition while project officials evaluated telemetry data and prepared a contingency operations plan for a spin-stabilized spacecraft. Weight: 1048 lb. Power: Solar Inclination: 31°
									Rubidium-vapor magnetometer–E	J. P. Heppner	GSFC	
									Spherical ion and electron trap–I	R. C. Sagalyn	AFCRL	
									Planar ion and electron trap–I	E. C. Whipple	GSFC	
									Radio propagation–I	R. S. Lawrence	NBS	
									Atmospheric mass spectrum–R	H. A. Taylor, Jr.	GSFC	
									Interplanetary dust particles–P	W. M. Alexander	GSFC	
									VLF noise and propagation–I	R. A. Helliwell	Stanford U.	
									Radio astronomy–A	F.T. Haddock	U. of Michigan	
									Geocoronal Lyman-alpha scattering–P	P. W. Mange	NRL	
									Gegenschein photometry–P	C. L. Wolff K. Hallam S. P. Wyatt	GSFC GSFC U. of Illinois	
									Solar cosmic rays–S	K. A. Anderson	U. of California	
									Plasma, electrostatic analyzer–E	J. H. Wolfe	ARC	
									Plasma, Faraday Cup–E	H. J. Bridge	MIT	
									Positron search and gamma-ray spectrum–ES	T. L. Cline E. W. Hones, Jr.	GSFC Inst. Def. Anal.	
									Trapped radiation, scintillation counter–E	A. Konradi	GSFC	
									Cosmic-ray isotope abundance–E	G. H. Ludwig F. B. McDonald	GSFC GSFC	

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PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

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OGO-I (Continued)									Cosmic-ray spectra and fluxes–E	J. A. Simpson	U. of Chicago	
									Trapped radiation, omnidirectional counters–E	J. A. Van Allen	U. of Iowa	
									Trapped radiation, electron spectrometer–E	J. R. Winckler R. L. Arnoldy	U. of Minnesota	
EXPLORER XXI INTERPLANETARY EXPLORER PLATFORM (IMP II) 1964 60A	A detailed study of the radiation environment of cislunar space and monitoring this region over a significant portion of a solar cycle (11 years). To study the quiescent properties of the interplanetary magnetic field and its dynamical relationships with particle fluxes from the sun. Development of a solar flare prediction capability for Apollo. The extension of knowledge of solar terrestrial relationships. To further the development of simple, inexpensive, spin-stabilized spacecraft for interplanetary investigation.	Oct. 4, 1964	Delta ETR	35 hours	120	59,400	Paul Butler Dr. F. B. McDonald	Carries 9 experiments; it is spin-stabilized and powered by solar cells. The system is designed so that data can be received from apogee by the GSFC Minitrack stations.	MAGNETIC FIELD Rubidium vapor magnetometer–E	N. F. Ness	GSFC	The satellite failed to achieve the required orbit of 161,000 mile apogee. Weight: 136 lb. Power: Solar
									Two fluxgate magnetometers–E	N. F. Ness	GSFC	
									COSMIC RAY Range versus energy loss–E	J. A. Simpson C. Y. Fan G. Gloeckler	Enrico Fermi Inst. U. of Chicago	
									Energy versus energy loss–E	F. B. McDonald	GSFC	
									Orthogonal telescope array–E	F. B. McDonald	GSFC	
									Neher-type ion chamber–E	K. A. Anderson	U. of California	
									SOLAR WIND Low-energy proton analyzer–E	J. H. Wolfe	ARC	
									Plasma probe–E	H. S. Bridge	MIT	
									Thermal ion electron sensor–E	R. Bourdeau G. P. Serbu	GSFC GSFC	
EXPLORER XXII BEACON EXPLORER-B 1964 64A	To study for a minimum period of 1 year the variations of electron content distribution as a function of latitude, and seasonal and diurnal time, under varying magnetic and solar conditions. To support the beacon experiment be determining the electron density in the vicinity of the spacecraft. To test the feasibility of laser tracking.	Oct. 9, 1964	Scout WTR	104	549	669	Frank T. Martin Robert E. Bourdeau	Four coherent, ultra-stable, unmodulated CW transmitters (operating at 20, 40 41, and 360 Mc) radiate signals from dipole antennas which are received by a world-wide network of over 80 observing stations. Two electron density probes. Laser corner reflector.	Ionosphere beacon–I	G. W. Swenson W. J. Ross U. K. Garriott R. S. Lawrence L. J. Blumle	U. of Illinois Pennsylvania State U. Stanford U. NBS GSFC International participants	Observing Stations: Stations operated by prime experimenters: a. University of Illinois: Urbana, Illinois Houghton, Michigan; Baker Lake, Canada; Adak, Alaska b. Pennsylvania State University; University Park, Pennsylvania Huanacyo, Peru
									Electron density–I	L. Brace	GSFC	
									Laser tracking	H. Plotkin	GSFC	

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E – Energetic Particles and Fields
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S – Solar Physics

PART I
GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	Launch and Orbit Data: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	Experiment Data: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
EXPLORER XXII (Continued)												c. Stanford University: Stanford, California; Honolulu, Hawaii Macapa, Brazil; S. J. dos Compos, Brazil; Santiago, Chile; Ushuaia, Argentina d. Central Radio Propagation Laboratory (NBS): Boulder, Colorado: 2 mobile stations within 100-mile radius of Boulder, Colorado. e. Goddard Space Flight Center (GSFC): Blossom Point, Maryland International Participation: More than 80 international observing ground stations are participating in the program. Laser stations located at Wallops Island and GSFC. Weight: 115 lb.
SAN MARCO-1	To measure air density of the upper atmosphere and electron density. To study radio wave propagation known as "ducting."	Dec. 15, 1964	Scout ETR	95	128	510	Anthony J. Caporale	Spacecraft spin-stabilized at 3 rpm. Powered by non-rechargeable batteries.	As the atmosphere exerts a force on the spacecraft, a three-axis balance measures relative movement between the outer, lighter sphere and the heavy inner mass. Electron content measured by Faraday rotation method.	L. Broglio N. Carrara	U. of Rome, Italy U. of Florence, Italy	An Italian satellite project. First satellite to be built and instrumented in Western Europe; first satellite launched in U.S. by non-U.S. crew.
EXPLORER XXVI ENERGETIC PARTICLES EXPLORER-D 1964 86A	To study the injection, trapping, and loss of mechanisms of the trapped radiation belt (natural and artificial). The particle measurements will be correlated with data from the magnetic field experiment.	Dec. 21, 1964	Delta ETR	456	190	16,250	Gerald W. Longanecker Leo Davis	The spacecraft is spin-stabilized at 25 rpm/ nominal and powered by p-on-n solar cells.	Electron-proton angular distribution and energy spectra Electron-proton directional-omnidirectional detectors Magnetic field measurements	W. L. Brown C. E. McIlwain Laurence Cahill	Bell Telephone Lab. U. of California U. of New Hampshire	The satellite continues the work of earlier satellites in the explorer series which measured the Van Allen and the artificial radiation belts, produced by the Starfish nuclear

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E – Energetic Particles and Fields
I – Ionospheric Physics
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P – Planetary Atmospheres
S – Solar Physics

PART I
GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	Launch and Orbit Data: Launch Date/ Silent Date	Launch and Orbit Data: Vehicle & Launch Site	Launch and Orbit Data: Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	Experiment Data: Instrumentation Summary	Experiment Data: Experiment and Discipline*	Experiment Data: Experimenter	Experiment Data: Affiliation	Remarks
EXPLORER XXVI (Continued)									Ion-electron detector Solar-cell damage	Leo R. Davis J. M. Williamson L. W. Slifer	GSFC GSFC	explosion in the Pacific. Weight: 101 lb. Power: Solar Inclination: 20.1° Results have shown an apparent diffusion of > 40 Mev protons in the L = 2 vicinity and an increase in the intensity of > 500 kev protons by a factor of 2 in the L = 2.5 to L = 5 region; over the same region the 100 to 300 kev protons are greatly depleted.
TIROS-9 A-54 1965 4A	To launch a wheel-made TIROS spacecraft that will contribute to the development of a global meteorological observation system.	Jan. 22, 1965	Delta ETR	119	436	1602	Robert Rados	Two standard TIROS cameras with recorders, two IR horizon sensors for attitude determination, a magnetic attitude control system; horizon sensors will be used with an on-board spacecraft computer to provide camera shutter at spacecraft local vertical. Magnetic spin control and spacecraft digital clock to be used.				To increase the area of meteorological observation, to improve the accuracy of TV picture location and to eliminate attitude constraints through the use of a cartwheel-configured satellite in a nearly sun-synchronous (82° retrograde) polar orbit. This configuration permits the cameras to view the earth and its cloud cover and is limited in coverage only by the sun's coverage of the earth. Weight: 305 lb. Power: Solar Inclination: 96.4°
ORBITING SOLAR OBSERVATORY OSO-II 1965 7A	To conduct experiments in solar physics above the earth's atmosphere; experiments will detect and measure electromagnetic radiation from the sun and determine its energy level.	Feb. 3, 1965 Nov. 6. 1965	Delta ETR	97	343	393	Laurence T. Hogarth Dr. John C. Lindsay	Stabilized platform for solar-oriented scientific instruments. Experiments not requiring fixed orientation with respect to the sun are housed in the spinning wheel section of the satellite. Electrical power is supplied by	POINTED Ultraviolet spectrometer-spectroheliograph 300-1400A-S Monitor solar X-ray bursts 2-8A, 8-20A, and 44-60A-S	L. Goldberg E. M. Reeves W. H. Parkinson W. Liller T. A. Chubb	Harvard U. NRL	Weight: 545 lb. (320 for spacecraft and 225 for experiments) Power: Solar Inclination: 33° Due to diminishing pitch gas supply, terminal maneuver

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E – Energetic Particles and Fields
I – Ionospheric Physics
A – Astronomy
P – Planetary Atmospheres
S – Solar Physics

PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	EXPERIMENT DATA: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
ORBITING SOLAR OBSERVATORY (Continued)								an array of solar cells mounted on the stabilized section. A complete telemetry and command system is provided to transmit information back to earth. Essential difference between OSO-1 and OSO-II is ability of OSO-II to scan solar disc and corona with pointed instruments.	White light coronograph-spectroheliograph Lyman-alpha, He I and He II lines–S	R. Tousey	NRL	was begun on September 24, 1965
									WHEEL Monitor intensity and direction of polarized light from interplanetary space–A	E. P. Ney	U. of Minnesota	
									Measure arrival direction and energies of primary cosmic-gamma rays 100 Mev to 1 Bev–A	C. P. Leavitt	U. of New Mexico	
									Detect gamma rays and analyze their energy spectrum 0.1-0.7 Mev–S	K. J. Frost	GSFC	
									Ultraviolet stellar and nebular spectrophotometer 1500-3200A – A	K. L. Hallam	GSFC	
									Measurement of thermal-radiation characteristics of surfaces to determine emissivity stability of spacecraft temperature-control coatings–E	C. B. Neel	ARC	
EARLY BIRD HS-303 (First satellite project of the Communications Satellite Corp.) 1965 28A	Communications	April 6, 1965	TAD ETR		22,300		C. P. Smith					GSFC provided launching and associated services. Satellite operation was the responsibility of the Communications Satellite Corp.
EXPLORER XXVII BE-C (IONOSPHERE BEACON) 1965 32A	Ionosphere: To study for a minimum period of 1 year the variations of electron content distribution as a function of latitude, and seasonal and dirunal time, under varying magnetic and solar conditions. To support the beacon experiment by determining the electron density in the vicinity of the spacecraft. To test the feasibility of laser tracking. Geodesy: To study detailed perturbations in orbits of satellites to deduce the size and shape of the	April 29, 1965	Scout WI	108	584	819	Frank T. Martin Ionosphere: Robert E. Bourdeau Geodesy: Robert Newton	Ionosphere: Four-coherent, ultrastable, unmodulated CW transmitters (operating at 20, 40, 41, and 360 Mc) radiate signals from dipole antennas which are received by a world-wide network of over 80 observing stations. Two electron density probes. Laser corner reflector. Geodesy: Two coherent, ultrastable, unmodulated CW transmitters (operating at 162 and 324 Mc) radiate signals from dipole antennas which are received by a world-wide network of over 80 observing	Ionosphere beacon–1	G. W. Swenson W. J. Ross U. K. Garriott R. S. Lawrence L. J. Blumle	U. of Illinois Pennsylvania State U. Stanford U. NBS GSFC International participants	Observing Stations: Stations operated by prime experimenters Ionosphere: a. University of Illinois Urbana, Illinois; Houghton, Michigan; Baker Lake, Canada; Adak, Alaska b. Pennsylvania State University; University Park, Pennsylvania Huancaye, Peru Geodesy: Tranet – APL
									Electron density–I	L. Brace	GSFC	
									Laser tracking	H. Plotkin	GSFC	
									Geodesy	Geodesy: R. Newton	APL	

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E – Energetic Particles and Fields
I – Ionospheric Physics
A – Astronomy
P – Planetary Atmospheres
S – Solar Physics

PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	EXPERIMENT DATA: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
EXPLORER XXVII (Continued)	earth and the nature of its gravity field.							stations. Two electron density probes. Laser corner reflector.				Laser: GSFC Inclination: 41°
EXPLORER XXVIII IMP III 1965 42A	To study in detail the radiation environment of cislunar space and to monitor this region over a significant portion of a solar cycle. To study the quiescent properties of the interplanetary magnetic field and its dynamical relationships with particle fluxes from the sun. To develop a solar flare prediction capability for Apollo. To extend the knowledge of solar terrestial relationships. To further the development of simple, in expensive, spin-stabilized spacecraft for interplanetary investigations.	May 29, 1965	Delta ETR	5 days 22-1/2 hr.	120	164,000	Paul Butler F. B. McDonald	Carrier 9 experiments. Spin-stabilized and powered by solar cells. The system is designed so that data can be received from apogee by the GSFC Minitrack stations.	MAGNETIC FIELD Rubidium vapor magnetometer—E	N. F. Ness	GSFC	Inclination: 34°
									Two fluxgate magnetometers—E	N. F. Ness	GSFC	
									COSMIC RAY Range versus energy loss—E	J. A. Simpson C. Y. Fan G. Gloeckler	Enrico Fermi Inst. U. of Chicago	
									Energy versus energy loss—E	F. B. McDonald	GSFC	
									Orthogonal telescope array—E	F. B. McDonald	GSFC	
									Neher-type ion chamber—E	K. A. Anderson	U. of California	
									SOLAR WIND Low-energy proton analyzer—E	J. Wolfe	ARC	
									Plasma probe—E	H. S. Bridge	Massachusetts Inst. of Tech.	
									Thermal ion electron sensor	R. Bourdeau G. P. Serbu	GSFC GSFC	
TIROS X 1965 51A OT-1	To provide additional operational data for WB requirements.	July 1, 1965	Delta ETR	100	458	518	Robert Rados					First operational TIROS weather satellite. Inclination: 98.63° The satellite was launched into a near-perfect sun-synchronous orbit. Precession of orbit was less than 2 degrees per year.
ORBITING SOLAR OBSERVATORY OSO-C	To conduct experiments in solar physics above the earth's atmosphere; experiments will detect and measure electromagnetic radiation from the sun and determine its energy level.	Aug. 25, 1965	Delta ETR	95.73	FAILURE		Laurence T. Hogarth Dr. John C. Lindsay	Stabilized platform for solar-oriented scientific instruments. Experiments not requiring fixed orientation with respect to the sun are housed in the spinning wheel section of the satellite. Electrical power is supplied by	POINTED Ultraviolet monochromator 250-1300A—S	H. E. Hinteregger	AFCRL	Weight: 619 lb. (367 for spacecraft and 252 for experiments)
									Solar spectrometer 1-400A—S	W. M. Neupert	GSFC	Power: Solar Inclination: 33°
									WHEEL Earth's albedo in ultraviolet and visible regions	C. B. Neel	ARC	The Delta's third stage failed; the satellite is believed

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PART I
GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
ORBITING SOLAR OBSERVATORY (Continued)								an array of solar cells mounted on the stabilized section. A complete telemetry system is provided to transmit information back to earth. Spacecraft has pointing capability similar to OSO-I and OSO-II.	3200-7800A and infrared to 30μ–A			to have impacted in the South Atlantic Ocean.
									Emissivity stability of low-temperature coatings–E	C. B. Neel	ARC	
									Celestial gamma-ray astronomy 100 Mev and greater–A	W. L. Kraushaar	MIT	
									Solar X-ray 8-20A–S	R. Teske	U. of Michigan	
									Cosmic-ray charge spectrum detector to measure nuclear component of primary radiation and high-energy gamma radiation > 100 Mev from sun and galaxy–S	M. F. Kaplon	U. of Rochester	
									Directional radiometer 1-30μ	C. B. Neel	ARC	
									Solar X-ray telescope 7-190 Kev and anti-coincidence events at 100 Kev and 2.5 Mev–S	L. E. Peterson	U. of California	
ORBITING GEOPHYSICAL OBSERVATORY OGO-II	To launch and operate an orbital spacecraft carrying experiments to make scientific geophysical measurements about the earth.	Oct. 14, 1965	TAT-Agena D WTR	104	257	938	Wilfred E. Scull N. W. Spencer	The third in a series of standardized "street car" satellites. The spacecraft can accommodate as many as 50 experiments.	Radio astronomy–A	F. T. Haddock	U. of Michigan	Weight: 1150 lb. Power: Solar Inclination: 87° Due to difficulties encountered in the attitude control system and the abnormal consumption of control gas, the satellite exhausted its supply of control gas and entered a random tumbling mode.
									VLF measurements–I	R. A. Helliwell	Stanford U.	
									VLF measurements–I	M. G. Morgan T. Laaspere	Dartmouth College	
									Triaxial search-coil magnetometer–E	R. E. Holzer E. J. Smith	UCLA JPL	
									Rubidium-vapor magnetometer–E	J. P. Heppner	GSFC	
									Cosmic-ray and polar-region ionization study–E	H. R. Anderson H. V. Neher	Rice Inst. Calif. Inst. Tech.	
									Energetic particles survey–E	J. A. Simpson	U. of Chicago	
									Galactic and solar-cosmic rays–E	W. R. Webber	U. of Minnesota	
									Corpuscular radiation in auroral and polar zones–E	J. A. Van Allen	U. of Iowa	
									Trapped-radiation scintillation detector–E	R. A. Hoffman	GSFC	
									Air-glow study–R	J. Blamont E. Reed	U. of Paris GSFC	

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PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
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					Perigee	Apogee						
ORBITING GEOPHYSICAL OBSERVATORY (Continued)									Lyman-alpha and air-glow study–R	P. W. Mange	NRL	
									Air-glow study, under-voltage spectrometer–R	C. A. Barth L. Wallace	JPL Kitt Peak Nat. Obs.	
									Neutral particles and ion-composition study–R	R. J. Leite	U. of Michigan	
									Positive ion study–R	H. A. Taylor, Jr.	GSFC	
									Neutral particle study–R	G. P. Newton	GSFC	
									Micrometeorites–P	W. M. Alexander	GSFC	
									Ionospheric composition and undervoltage flux–I	R. E. Bourdeau	GSFC	
									Solar X-rays–S	R. W. Kreplin	NRL	
									Undervoltage spectro-meter–S	H. E. Hinteregger	AFCRL	
ISIS-X (DME-A ALOUETTE B)	Sounding the top side of the iono-sphere by utilizing topside sounder and measurement techni-ques	Nov. 29, 1965	Thor-Agena B WTR	121	329	1837	E. Dale Nelson J. E. Jackson		Topside Sounding of the Ionosphere Galactic and solar radio noise Investigating whistlers Energetic particles Langmuir probes			Inclination: 80° A second Canadian Alouette satellite and another U. S. Explorer satellite were launched simultaneously. This double-launch project, known as ISIS-X, was the first in a new cooperative NASA/Canadian Defense Research Board program for international satellites for ionospheric studies (ISIS). Alouette II was designed and built by Canada's DRB; the Explorer was designed and built for GSFC by APL.
FRENCH FR 1-A	To study the proper-ties of the VLF wave field in the mag-netosphere; to study the irregularities and the distribution of ionization in the magnetosphere.	Dec. 6, 1965	Scout WTR	99.83	461	471	S. R. Stevens R. W. Rochelle		VLF Experiment	L. R. O. Storey	CNET France (Centre National d'Etudes de Tele-Commun-ication)	75.87° Inclination. Functioning as predicted.
ESSA I	To provide opera-tional data for Weather Bureau requirements.	Feb. 3, 1966	Delta-DSV-3 ETR	100	432.9	522.6	Robert Rados	Two standard TIROS cameras with recorders, two IR horizon sensors for attitude determina-tion, a magnetic				This mission will endeavor to increase the area of meteoro-logical observation, to improve the

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E – Energetic Particles and Fields
I – Ionospheric Physics
A – Astronomy
P – Planetary Atmospheres
S – Solar Physics

PART I

GODDARD SPACE FLIGHT CENTER SATELLITES AND SPACE PROBE PROJECTS (Cont.)

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ESSA I (Continued)								attitude control system; horizon sensors will be used with an onboard spacecraft computer to provide camera shutter at spacecraft local vertical. Magnetic spin control and spacecraft digital clock to be used.				accuracy of TV picture location and to eliminate attitude constraints through the use of a cart-wheel configured satellite in a nearly sun-synchronous (82° retrograde) polar orbit. This configuration will permit the cameras to view the earth and its cloud cover and will be limited in coverage only by the sun's coverage of the earth. Weight: 305 lb. Power: Solar Inclination: 81°
ESSA II OT-2	To provide continuous observation of the earth's cloud cover with direct readout TV data on a global basis.	Feb. 28, 1966	Improved TAD ETR	113.4	843	885	W. W. Jones	Contains APT camera system similar to TIROS VIII and and Nimbus I.				An operational weather satellite system developed by NASA for the U. S. Weather Bureau. Cartwheel configuration, sun-synchronous orbit permits complete coverage of world's weather. Weight: 290 lb. Inclination: 79°
ORBITING ASTRONOMICAL OBSERVATORY I	To make precise telescope observations from above the earth's atmosphere with satellites under control from the ground. The area of interest is that of the emission and absorption characteristics of the sun, stars, planets, nebulae and interplanetary and interstellar media in the relatively unexplored infrared, ultraviolet, X-ray and gamma-ray regions of the spectrum. To develop a basic spacecraft which will have the precise pointing capability, power and data-handling equipment, etc.	April 8, 1966	Atlas-Agena ETR		434 ± 22 Circular 428.6 n.mi.	Orbit 439.2 n.mi.	Robert R. Ziemer Dr. J. E. Kupperian, Jr.	Carried a wide variety of astronomical experiments	(OAO A-1) Broadband photometric studies of stellar energy distribution (3000-800A) (OAO A-1) The discovery and location of new sources of soft X-ray emissions (OAO A-1) To measure intensity and arrival direction of energetic gamma rays (OAO A-1) To survey the celestial sphere for photons in the 2-to-180-kev range and to measure the spectrum of the fluxes detected	A. Code P. C. Fisher W. Kraushaar K. Frost	U. of Wisc. Lockheed MIT (U. of Wisc.) GSFC	Approx. Observatory Weight: 3900 434 n. mi. 35° Shortly after orbiting OAO I began having battery heating problems and other electrical malfunctions. After 1-1/2 days in orbit, the last battery failed; OAO I ceased transmitting without having returned any scientific data.

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Designation	Objectives	Launch and Orbit Data: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	Experiment Data: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
ORBITING ASTRONOMICAL OBSERVATORIES OAO-A1 OAO-B OAO-A2 OAO-C (Continued)									(OAO-B) Absolute spectrophotometry measurement (1000-4000A with 2A resolution)–A (OAO A-2) Broadband photometric studies of stellar energy distribution (3000-800A) (OAO A-2) Mapping stellar undervoltage radiation in ranges 3000-1700A, 200-1050A, 1500-1050A (OAO C) Interstellar absorption measurement (800-3000A with 0.1 resolution)-A (OAO C) To study X-ray radiation in wavelength bands 3-9A, 8-18A and 44-60A	J. Kupperian J. Mulligan A. Code F. Whipple L. Spitzer R. Boyd	GSFC GSFC U. of Wisc. Smithsonian Astrophysical Observatory Princeton Univ. Univ. College London	
NIMBUS II	To extend the meteorological data obtained with Nimbus I to a broad range of seasonal and hemispheric variations in weather systems, and to test new sensors in the infrared radiation region.	May 15, 1966	TAT-Agena B WTR	108	681	733	Harry Press William Nordberg	Television cameras to photograph earth's cloud cover; equipment for infrared radiation measurements. Two large paddles of solar cells convert the sun's energy into electric power. Spacecraft also has tape recorders PCM telemetry, and 128 coded commands.	Advanced vidicon camera system Automatic picture transmission system High-resolution infrared radiometer Medium-resolution infrared radiometer	J. R. Schulman J. R. Schulman L. L. Foshee A. W. McCulloch	GSFC GSFC GSFC GSFC	Weight: 935 lb. Power: Solar Inclination: 80° retrograde Direct readout of of infrared pictures at APT stations. All sensors returned good data for both R&D and operational purposes.
EXPLORER XXXII ATMOSPHERE EXPLORER AE-B	To study the structure and physics of the upper atmosphere between 135 and 650 statute miles.	May 25, 1966	Delta ETR	116	180	1688	C. C. Stephanides L. H. Brace	Experiments consist of two double-focusing magnetic neutral-particle mass spectrometers, three cold-cathode total-pressure ionization gauges, two electrostatic probes, and one Bennett-type ion-mass spectrometer. The spacecraft contains an active magnetic attitude control system,	Neutral Particle Mass Spectrometers–RP Pressure Gauges–RP Electrostatic Probes–RPI Ion Mass Spectrometer–RPI	C. Reber J. Cooley G. P. Newton L. Brace H. A. Taylor H. Brinton R. A. Pickett		Weight: 483 lb. Power: Battery (Primary) Limited solar recharging capability The orbit was more elliptical than planned.

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EXPLORER XXXII ATMOSPHERE EXPLORER AE-B (Continued)								redundant PCM telemetry systems and a tape recorder.				Second stage burned too long, giving higher apogee than planned. Experiments performed well; higher orbit would be used for studies of density drag.
ORBITING GEOPHYSICAL OBSERVATORY OGO-III	To launch and operate an orbital spacecraft carrying experiments to make scientific geophysical measurements about the earth.	June 6, 1966	Atlas-Agena B ETR	48.63 hrs.	183.2	75,842	Wilfred E. Scull Dr. G. H. Ludwig	The third in a series of standardized "street car" satellites. The spacecraft can accommodate as many as 50 experiments.	Solar cosmic rays–S	K. A. Anderson	U. of California	Weight: 1133 lb. Power: Solar The satellite lost its capability to be earth-anchored on on July 23, 1966 and became spin-stabilized.
									Plasma, electrostatic analyzer–E	J. H. Wolfe	ARC	
									Plasma, Faraday Cup–E	H. J. Bridge	MIT	
									Positron search and gamma-ray spectrum–E&S	T. L. Cline E. W. Hones, Jr.	GSFC Inst. Def. Anal.	
									Trapped radiation, scintillation counter–E	A. Konradi	GSFC	First highly elliptical orbit satellite to be three-axis stabilized. All 21 experiments operated, returned good data.
									Cosmic-ray isotopic abundance–E	F. B. McDonald	GSFC	
									Cosmic-ray spectra and fluxes–E	J. A. Simpson	U. of Chicago	
									Low energy electrons and protons–E	J. A. Van Allen	State U. of Iowa	
									Trapped radiation, electron spectrometer and ionization chamber–E	J. R. Winckler R. L. Arnoldy	U. of Minnesota	
									Low energy protons–E	D. S. Evans	GSFC	
									Triaxial search-coil magnetometer–E	E. J. Smith R. E. Holzer	JPL UCLA	
									Rubidium-vapor magnetometer–E	J. P. Heppner	GSFC	
									Spherical ion and electron trap–I	R. C. Sagalyn	AFCRL	
									Planar ion and electron trap–I	E. C. Whipple	ESSA	
									Radio propagation–I	J. K. Hargreaves	ESSA	
									Atmospheric mass spectrum–R	H. A. Taylor, Jr.	GSFC	
									Interplanetary dust particles–P	J. L. Bohn	Temple U.	

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ORBITING GEOPHYSICAL OBSERVATORY OGO-III (Continued)									VLF noise and propagation–I	R. A. Helliwell	Stanford U.	
									Radio astronomy–A	F. T. Haddock	U. of Michigan	
									Geocoronal Lyman-alpha scattering–P	P. M. Mange	NRL	
									Gegenschein photometry – P	C. L. Wolff S. P. Wyatt	GSFC U. of Illinois	
								Plasma Probe	Solar wind plasma	H. S. Bridge	MIT	
EXPLORER XXXIII ANCHORED IMP IMP D (AIMP)	To anchor a satellite about the moon, to measure in detail the solar plasma/flux, energetic particle population, magnetic fields, and cosmic dust in this orbit, and to explore the variations of the moon's gravitational field and search for a possible lunar ionosphere.	July 1, 1966	Improved TAD ETR	13.9 days to 20.0 days fluctuating	18.000	284.000 (fluctuating)	P. G. Marcotte N. F. Ness	Magnetometer	Magnetic fields	N. F. Ness	GSFC	The AIMP D Spacecraft failed to achieve orbit around the moon. A highly eccentric earth orbit with the apogee point beyond lunar orbit. Permits the study of solar plasma, energetic particles and magnetic fields.
								Thermal Ion	Low energy plasma	G. P. Serbu and E. J. Maier	GSFC	
								Magnetometer	Magnetic fields	C. P. Sonnett	Ames	
								Ion chamber and two Gieger tubes	Energetic particles	K. A. Anderson	UCLA	
								Three Gieger tubes and one p-n junction	Energetic particles	J. A. Van Allen		
ESSA III TOS-A	To provide continuing observation of the earth's cloud cover stored on a global basis. TV data stored on tape recorder and read out at CDA stations.	Oct. 2, 1966	Improved TAD WTR	114.5	860	924	W. W. Jones					

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PART I

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		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
INTELSTAT II-F1		Oct. 26, 1966	Improved TAD ETR	1440	2,122	23,271	C. P. Smith					Communications: Second ComSat Corp. commercial satellite, NASA provided reimbursable launch support. Capable of handling TV, data transmissions or up to 240 voice channels, part of capacity to be purchased by NASA for Apollo support. Planned geostationary about 176° East (Pacific). However, this satellite failed to achieve synchronous orbit due to a malfunction of the apogee Kick motor. This limited satellite use to approximately 8 hrs. for U.S./Pacific communications.
APPLICATIONS TECHNOLOGY SATELLITE-1	To flight test and conduct R and D with technology that is a common requirement of a number of spin-stabilized satellite applications. This includes communications, meteorology and control systems. To measure the environment of the stationary orbit and the effect of this environment on the spacecraft.	Dec. 6, 1966	Atlas-Agena D ETR	1440	22,300		Robert J. Darcey	Scientific, technological communications and meteorological instrumentation aboard a single spacecraft.	Communication Experiments: 2 SHF repeaters with uplink at 6000 Mc and downlink at 4000 Mc used for multiple access, and wideband data including color TV relay. Downlink only used to transmit cloud cover pictures.	P. Corrigan	GSFC	Weight in orbit: 790 pounds.
									1 VHF repeater with uplink at 149.22 Mc and downlink at 135.6 Mc used for ground-to-aircraft relay communications and relay of WEFAX material.	P. Corrigan	GSFC	Circular orbit with zero inclination over equator.
									Technology Experiments: Electronically de-spun phased array antenna used with SHF repeaters to produce radiated power of 14 decibels towards earth.	B. Pickard	GSFC	
									Nutation Sensor to measure spin axis wobble from 5 degrees to a thousandth of a degree.	P. Corrigan	GSFC	

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		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
									Resisto Jet to be evaluated as low thruster for de-spin and orbital manuever use. Thrust measured at 450 millionths of a pound.	D. Suddeth	GSFC	
									Scientific Experiments:			
									Environmental Measurement Experiment (EME) contains seven separate experiments:			
									1. Suprathermal Ion Detector	J. Freeman	Rice U.	
									2. Magnetometer	P. Coleman	UCLA	
									3. Omnidirectional Electron-Proton Detector	G. Paulikas	Aerospace Corp.	
									4. Electron Magnetic Deflection Spectrometer	J. Winckler	U. of Minn.	
									5. Multi-element Particle Telescope	W. Brown	BTL	
									6. Solar Radiation Damage	R. Waddel	GSFC	
									7. Thermal Coatings	J. Triolo	GSFC	
									Meteorological Experiments			
									Spin Scan Cloud Camera to use spacecraft spin in generating 2000-line photos of 40 percent of earth.	V. Suomi	U. of Wisc.	
									Weather Facsimile (WEFAX) to relay meteorological across globe to via ATS-1 VHF repeater to Automatic Picture Transmission (APT) within view of spacecraft.	B. Drummond	GSFC	

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PART II
SCHEDULED SATELLITE PROJECTS, PARTIAL LISTING

Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
INTELSAT II-F2		3Q66	Improved TAD ETR	1440	22,250		C. P. Smith					A project of the Communications Satellite Corporation
APPLICATIONS TECHNOLOGY SATELLITE-A Also scheduled are: ATS-C ATS-D ATS-E	To obtain engineering data on earth-oriented gravity-gradient stabilization at medium altitudes to extend techniques to synchronous altitudes: also to investigate gravity gradient stabilization for use on communications and meteorological satellite systems and to measure orbital environment.	4Q66	Atlas-Agena D ETR	360	6,720		Robert J. Darcey	Experiments: Communications: 2 microwave (SHF) repeaters Meteorological: 2 AVCS cameras – one wide angle, one narrow angle Gravity-gradient control stabilization system will provide performance data utilizing attitude data and cameras to observe boom deflections. Gravity-gradient camera, meteorological pictures, and communications will be transmitted via a 4-k Mc transmitter. Environmental and technical experiments will be transmitted at 136 Mc.	ATS-A			Weight: 702 lb. ATS-A Power: Solar array Period: 6-1/2 hrs.
									Omnidirectional particle detectors	C. McIlwain	U. of California	
									Multi-element silicon junction particle detector	W. L. Brown	BTL	
									VLF whistler mode detector	W. L. Brown	BTL	
									Electron magnetic deflection spectrometer	J. Winckler	U. of Minnesota	
									Solar-cell radiation damage	R. Waddel	GSFC	
									Thermal coating	J. J. Triolo	GSFC	
									Cosmic radio noise measurement	R. G. Stone	GSFC	
									Electric field measurements	T. Aggson	GSFC	
ORBITING SOLAR OBSERVATORY	To conduct experiments in solar physics above the earth's atmosphere; experiments will detect and measure electromagnetic radiation from the sun and celestial sphere and determine its energy level.	4Q 66	Delta ETR	95.73	345 circular orbit		Laurence T. Hogarth	Stabilized platform for solar-oriented scientific instruments. Experiments not requiring fixed orientation with respect to the sun are housed in the spinning wheel section of the satellite. Electrical power is supplied by an array of solar cells mounted on the stabilized section. A complete telemetry system is provided to transmit information back to earth. Spacecraft has pointing capability similar to OSO-I and OSO-II	POINTED Ultraviolet monochromator 250-1300A-S	H. E. Hinteregger L. A. Hall	AFCRL	Weight: 619 lbs. (367 for spacecraft and 252 for experiments) Power: Solar Inclination: 33°
									Solar spectrometer 1-400A-S	W. M. Neupert W. A. White	GSFC	
									WHEEL Earth's albedo in ultraviolet and visible regions 3200-7800A and infrared to 30μ-A	C. B. Neel	ARC	
									Emissivity stability of low-temperature coatings – E	C. B. Neel	ARC	
									Directional radiometer to measure intensity of total sunlight reflected from earth, and total radiant power (reflected and radiated).	C. B. Neel	ARC	

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ORBITING SOLAR OBSERVATORY (Continued)									Celestial gamma-ray astronomy 100 Mev and greater – A	W. L. Kraushaar G. W. Clark G. Gamire	MIT	
									Solar X-ray 8 – 14A-S	R. Teske	U. of Michigan	
									Cosmic-ray charge spectrum detector to measure nuclear component of primary radiation and high energy gamma radiation > 50 Mev from sun and galaxy-X	M. F. Kaplon C. L. Deney B. Dennis	U. of Rochester	
ESRO-I		1967	Scout WTR				E. Hymowitz Dr. L. Meredith					
ESRO-II		1967	Scout WTR				H. Eaker Dr. L. Meredith					
INTERNATIONAL SATELLITE UK-E & F (UK-3)	To measure vertical distribution of molecular oxygen in earth's atmosphere. To map large scale RF-noise sources in the galaxy, 2-to 5 Mc. To investigate VLF radiation, 3 to 16 kc, both natural and man-made. To measure ionization density and temperature above the F_2 maximum. To investigate terrestrial radio noise at 5, 10, and 15 Mc – (thunderstorms).	1967	Scout WTR	100	340	340	E. Hymowitz	P-Xylene ion-chamber, three radio receivers, and RF plasma probe.	P-Xylene ion-chamber	R. Frith	Meteorological Office, Brackwell	Weight: 179 lb. (orbital) Power: Solar Inclination: 80°
									Three radio receivers – A-P	F. G. Smith	U. of Manchester	
									Radio receivers – A-P	T. R. Kaiser	U. of Sheffield	
									RF plasma probe – I	J. Sayers	U. of Birmingham	
									Radio receiver – A-P	J. A. Ratcliffe, FRS	Radio Research Station, Slough	
INTERPLANETARY MONITORING PLATFORM IMP-F	To study solar and galactic cosmic radiation, the solar plasma, energetic particles within the magnetosphere and its boundary layer and the interplanetary magnetic field. These spacecraft are intended to continue and advance the studies carried out by earlier Explorer and IMP-type satellites. However, the experiments and instrumentation of IMP G permit more detailed and precise measurements than previously possible.	1967	Delta C WTR	4 days	122	122,000	P. Butler F. B. McDonald	Carries 11 experiments Spin-stabilized and powered by solar cells. The system is designed so that data can be received from apogee by the GSFC Minitrack stations.	ENERGETIC PARTICLES Low energy telescope	W. L. Brown	Bell Telephone Lab.	
									Neher-type ion chamber	K. A. Anderson	U. of California	
									Range versus energy loss	J. A. Simpson	U. of Chicago	
									Cosmic ray anisotropy	K. G. McCracken	Southwest Center for Advanced Studies	
									Solar proton monitoring	C. Bostrom and F. B. McDonald	Applied Physics Lab/GSFC	

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SCHEDULED SATELLITE PROJECTS, PARTIAL LISTING (Cont.)

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INTERPLANETARY MONITORING PLATFORM IMP-F (Continued)									Energy versus energy loss	F. B. McDonald	GSFC	
									Low energy proton and alpha detector	D. E. Hagge	GSFC	
									PLASMA			
									Plasma experiment	K. W. Ogilvie and T. D. Wilkerson	GSFC/ U. of Maryland	
									ENERGETIC PARTICLES & PLASMA			
									Low energy proton and Electron Differential energy analyzer	L. A. Frank and J. A. Van Allen	U. of Iowa	
									Spherical electrostatic analyzer	F. B. Harrison	Thompson Ramo-Wooldridge Systems	
									MAGNETIC FIELDS			
									Magnetic field experiment	N. F. Ness	GSFC	
ISIS-A	Ionospheric Studies	1967	Improved TAD WTR	127	310	2200	E. D. Nelsen J. Jackson	Swept Frequency Sounder		E. Warren/ G. L. Nelms	DRTE	
								Fixed Frequency Sounder		W. Calvert/ T. Von Zand	ITSA	
								VLF Receiver		R. Barrington/ J. Belrose	DRTE	
								Energetic Particle Detectors		J. McDiarmid	NRC	
								Soft Particle Spectrometer		W. Heikkila	GRCS	
								Ion Mass Spectrometer		R. Narcisi	AFCRL	
								Cylindrical Electrostatic Probe		L. Brace/ J. Findlay	GSFC	
								Spherical Electrostatic Analyzer		R. Sagalyn	AFCRL	
								Beacon (136/137 Mc/s)		R. Forsyth	UWD	
								Cosmic Noise		T. Hartz	DRTE	
NIMBUS-B A-5	Temperature soundings and other measurements of atmospheric structure. An experiment in the collection of meteorological data by satellite from a network of fixed and free-floating platforms. Determination of the earth's heat budget.	1967	Thorad/ Agena D WTR	107	690	690	H. Press W. Nordberg	Earth pointing attitude control stabilized in all three axes. Solar power supply (185 watts average) supplemented by 50 watts continous from Radioisotopic thermoelectric generator. Data storage by tape recorders and solid core memory, transmission over wideband	Michelson Infrared Interferometer-spectrometer (IRIS)	R. Hanel	GSFC	Weight – 1400 lbs. Sun synchronous high noon orbit. A real-time telemetry system will provide day (IDCS) and night (HRIR) cloud cover data to local meteorological users through the world-wide network of APT stations developed
									Fastie-Ebert satellite infrared spectrometer (SIRS)	D. Wark	NWSC	
									High Resolution Infrared Radiometer (HRIR)	L. Foshee	GSFC	
									Interrogation, recording,	G. Hogan	GSFC	

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PART II

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NIMBUS-B A-5 (Continued)	Measurement of direct and reflected ultra-violet radiation. Demonstration of the use of a radioisotope power supply for meteorological satellites.							telemetry links at 1700, 400 and 136 MHZ. Digital command system utilizing two redundant receivers and decoders, 258 commands.	and location system (IRLS)	J. Cressy	GSFC	for Nimbus I and II.
									Medium Resoiution Infra-red Radiometer (MRIR)	A. McCulloch	GSFC	
									Solar Ultraviolet Detector (SUV)	D. Heath	GSFC	
									Image Diesector Camera System (IDCS)	M. Schneebaum	GSFC	
ORBITING GEOPHYSICAL OBSERVATORY OGO-D	To launch and operate an orbital spacecraft carrying experiments to make scientific geophysical measurements about the earth.	1967	TAT/ Agena D WTR	97	207	575	Wilfred E. Scull N. W. Spencer	The fourth in a series of standardized "street car" satellites. The spacecraft can accommodate as many as 50 experiments.	Radio astronomy – A	F. T. Haddock	U. of Michigan	Weight: 1211 lb. Power: Solar Inclination: 86°
									VLF measurements – I	F. A. Helliwell	Stanford U.	
									VLF measurements – I	M. G. Morgan T. Laaspere	Dartmouth College	
									Triaxial search-coil magnetometer – E	R. E. Holzer E. J. Smith	UCLA JPL	
									Rubidium-vapor magnetometer – E	J. C. Cain	GSFC	
									Cosmic-ray and polar-region ionization study-E	H. R. Anderson H. V. Neher	Rice Inst. California Inst. Tech.	
									Energetic particles survey – E	J. A. Simpson	U. of Chicago	
									Galactic and solar-cosmic rays – E	W. R. Webber	U. of Minnesota	
									Corpuscular radiation in auroral and polar zones – E	J. A. Van Allen	State U. of Iowa	
									Trapped-radiation scintillation detector - E	R. A. Hoffman	GSFC	
									Air-glow study – R	J. Blamont E. Reed	U. of Paris GSFC	
									Lyman-alpha and air-glow study – R	P. W. Mange	NRL	
									Air-glow study, under-voltage spectrometer – R	C. A. Barth L. Wallace	JPL Kitt Peak Nat. Obs.	
									Neutral particles and ion-composition study – R	R. Leite	U. of Michigan	
									Positive ion study – R	H. A. Taylor, Jr.	GSFC	
									Neutral particle study – R	G. P. Newton	GSFC	
									Micrometeorites – P	C. S. Nilsson	GSFC	

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SCHEDULED SATELLITE PROJECTS, PARTIAL LISTING (Cont.)

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ORBITING GEOPHYSICAL OBSERVATORY OGO-D (Continued)									Ionospheric composition and undervoltage flux - I	R. E. Bourdeau	GSFC	
									Solar ultraviolet spectrometer - S	H. E. Hinteregger	AFCRL	
									Solar X-rays - S	R. W. Kreplin	NRL	
ORBITING GEOPHYSICAL OBSERVATORY OGO-E	To launch and operate an orbital spacecraft carrying experiments to make scientific geophysical measurements about the earth.	1967	Atlas/ Agena D ETR	63.35 hours	172	92,000	Wilfred E. Scull Dr. J. P. Heppner	The fifth in a series of standardized "street car" satellites. The spacecraft can accommodate as many as 50 experiments.	Electron temperature and density - IE	R. L. F. Boyd	Univ. College, London	Weight: 1275 lb. Power: Solar Inclination: 31°
									Thermal and epithermal plasma measurements - IE	R. C. Sagalyn	AFCRL	
									Electron and ion measurement 0-100 ev - IE	G. P. Serbu	GSFC	
									Energetic radiations from solar flares - SE	K. A. Anderson	U. of California	
									Low-rigidity interplanetary electrons, positrons, and protons - E	T. L. Cline	GSFC	
									Electron and proton spectrometer - E	R. D'arcy	LRL	
									Low-energy electron and proton detector - IE	L. A. Frank	State U. of Iowa	
									Energetic protons in primary cosmic rays - EA	G. W. Hutchinson	U. of Southhampton, England	
									Cosmic-ray electrons - E	P. Meyer	U. of Chicago	
									Galactic and solar-cosmic rays - E	F. B. McDonald	GSFC	
									Triaxial electron analyzer - IE	K. W. Ogilvie T. D. Wilkerson	GSFC U. of Maryland	
									Plasma spectrometer - IE	C. W. Snyder	JPL	
									Energetic cosmic ray electrons - E	A. H. Wapstra	Netherlands Inst. of Nuclear Physics	
									Hydromagnetic waves and trapped particles - E	P. J. Coleman D. L. Judge	UCLA U. of Southern California and TRW	
									Magnetic field measurements - E	J. P. Heppner	GSFC	

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PART II
SCHEDULED SATELLITE PROJECTS, PARTIAL LISTING (Cont.)

Designation	Objectives	Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles Perigee	Statute Miles Apogee	Project Manager and Project Scientist	Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
ORBITING GEOPHYSICAL OBSERVATORY OGO-E (Continued)									Search coil magnetometer - E	E. J. Smith R. E. Holzer	JPL JPL and UCLA	
									Plasma waves	G. M. Crook	TRW	
									Ultraviolet photometric measurements - AI	C. A. Barth	U. of Colorado	
									Geocoronal hydrogen - ASE	J. E. Blamont	U. of Paris	
									Solar X-rays	R. W. Kreplin	NRL	
									Light ion mass spectrometer - PI	C. W. Sharp	LMSC	
									Radio astronomy - A	F. T. Haddock	U. of Michigan	
									Electric field measurements - E	T. L. Aggson	GSFC	
									Hi Z - Low E - E	J. A. Simpson	U. of Chicago	
ORBITING SOLAR OBSERVATORY OSO-D	To conduct experiments in solar physics above the earth's atmosphere; experiments will detect and measure electromagnetic radiation from the sun and celestial sphere determine its energy level.	1967	Delta ETR	95.73	345 circular orbit		Laurence T. Hogarth	Stabilized platform for solar-oriented scientific instruments. Experiments not requiring fixed orientation with respect to the sun are housed in the spinning wheel section of the satellite. Electrical power is supplied by an array of solar cells mounted on the stabilized section. A complete telemetry system is provided to transmit information back to earth. Spacecraft has pointing and scanning capability similar to OSO-B2.	POINTED Solar X-ray telescope 3-13A, 3-21A, 3-20A, 70A, and map the sun in X-rays - S	R. Giacconi F. R. Paolini H. Friedman	American Science & Engineering, Inc.	Weight: 570 lb. (330 for spacecraft and 240 for experiments) Power: Solar Inclination: 33°
									Bragg crystal X-ray spectrometer 1-8A - S	T. A. Chubb R. W. Kreplin J. F. Meekins	NRL	
									Improved normal incidence 300-1300A scanning spectrometer spectroheliograph - S	L. Goldberg E. M. Reeves W. H. Parkinson	Harvard College Observatory	
									WHEEL Measure extrasolar X-radiation 0.5-30 kev.	R. Giacconi H. Gursky	American Science & Engineering, Inc.	
									Distribution of total solar X-ray emission over a wide band 1-20A and 44-75A - S	R. L. F. Boyd K. A. Pounds	U. College, London; & Leicester U.	
									Study of solar He II 304A resonance emission - S	R. L. F. Boyd E. A. Stewardson	U. College, London	
									Proton-electron detector electrons > 60 kev, protons > 2 Mev - E	J. Waggoner	U. of California Lawrence Radiation Lab.	

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PART II
SCHEDULED SATELLITE PROJECTS, PARTIAL LISTING (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	EXPERIMENT DATA: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
ORBITING SOLAR OBSERVATORY OSO-D (Continued)									X-ray ion chamber monitoring 0.5-3A, 2-8A, 8-16A, and 44-60A – S Lyman-alpha nightsky glow 1050-1350A which includes the alpha line 1216A – A	T. A. Chubb R. W. Kreplin H. Friedman P. W. Mange T. A. Chubb H. Friedman	NRL NRL	
RAE-A (Radio Astronomy Sat.)		1967	Improved TAD WTR	228	3728		J. Shea Dr. R. Stone					
SAN MARCO SM-B	To measure upper atmosphere air density. To measure electron density and to study radio wave propagation effect known as "ducting."	1967	Scout E. Africa		130	150	A. J. Caporale	Spacecraft is not stabilized. Powered by nonrechargeable batteries.	Air density measured by triaxial balance Electron content and wave propagation	L. Broglio N. Carrara	U. of Rome, Italy U. of Florence, Italy	
SAN MARCO (BU) SM-C	To measure upper atmosphere air density. To measure electron density and to study radio wave propagation effect known as "ducting."	1967	Scout E. Africa		130	500	A. J. Caporale	Spacecraft is not stabilized. Powered by nonrechargeable batteries.	Air density measured by triaxial balance Electron content and wave propagation	L. Broglio N. Carrara	U. of Rome, Italy U. of Florence, Italy	
TOS-B (Tiros Operational Sat.)		1967	Improved TAD WTR				W. W. Jones					
TOS-C (Tiros Operational Sat.)		1967	Improved TAD WTR				W. W. Jones					
TOS-D (Tiros Operational Sat.)		1967	Improved TAD WTR				W. W. Jones					
TOS-E (Tiros Operational Sat.)		1967	Improved TAD WTR				W. W. Jones					
TOS-F (Tiros Operational Sat.)		1967	Improved TAD WTR				W. W. Jones					
TOS-G (Tiros Operational Sat.)		1967	Improved TAD WTR				W. W. Jones					
IMP-G	To study solar and galactic cosmic radiation, the solar plasma, energetic particles within the magnetosphere and	1968	Improved TAD WTR	4 days	121	126,676	P. Butler Dr. F. McDonald	Carries 11 experiments. Spin-stabilized and powered by solar cells. The system is designed so that data can be received from apogee by	ENERGETIC PARTICLES Low energy telescope	W. L. Brown	Bell Telephone Lab.	Inclination: 66.5°

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PART II

SCHEDULED SATELLITE PROJECTS, PARTIAL LISTING (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Statute Miles: Apogee	Project Manager and Project Scientist	EXPERIMENT DATA: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
IMP-G (Continued)	its boundary layer and the interplanetary magnetic field. These spacecraft are intended to continue and advance the studies carried out by earlier Explorer and IMP-type satellites. However, the experiments and instrumentation of IMP-G permit more detailed and precise measurements than previously possible.							GSFC Minitrack stations.	Neher-type ion chamber	K. A. Anderson	U. of California	
									Range versus energy loss	J. A. Simpson	U. of Chicago	
									Cosmic ray anisotropy	K. G. McCracken	Southwest Center for Advanced Studies	
									Solar proton monitoring	C. Bostrom and F. B. McDonald	Applied Physics Lab/GSFC	
									Energy versus energy loss	F. B. McDonald	GSFC	
									Low energy proton and and alpha detector	D. E. Hagge	GSFC	
									PLASMA			
									Plasma experiment	K. W. Ogilvie and T. D. Wilkerson	GSFC/U. of Maryland	
									ENERGETIC PARTICLES and PLASMA			
									Low energy proton and electron differential energy analyzer	L. A. Frank and J. A. Van Allen	U. of Iowa	
									Spherical electrostatic analyzer	F. B. Harrison	Thompson-Ramo-Wooldridge Systems	
									MAGNETIC FIELDS			
									Magnetic field experiment	N. F. Ness	GSFC	
ISIS-B	Ionospheric Studies	1968	Improved TAD WTR	192	1100	1100	E. D. Nelsen J. Jackson					
OGO-F S-60	To launch and operate an orbital spacecraft carrying experiments to make scientific geophysical measurements about the earth.	1968	Thor/ Agena D WTR	99.48	230	690	W. E. Scull N. W. Spencer	The sixth in a series of standardized "street car" satellites. The spacecraft can accommodate as many as 50 experiments.	Atmospheric density-R	G. W. Sharp	LMSC	Weight: 1327 lbs. Power: Solar Inclination: 86°
									Electron temperature and density-R	A. F. Nagy	U. of Michigan	
									Ionospheric duct detector-R	W. B. Hanson	GRCS	
									Atmospheric composition -R	C. A. Reber	GSFC	
									Ion concentration and mass-R	R. Picket	GSFC	
									Ion mass spectrometer -R	W. B. Hanson	GRCS	
									Energy transfer probe-R	D. McKeown	Gen. Dyn.	

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PART II

SCHEDULED SATELLITE PROJECTS, PARTIAL LISTING (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
OGO-F S-60 (Continued)									Solar x-ray spectrometer-S	R. W. Kreplin	NRL	
									Solar UV-S	D. E. Bedo	AFCRL	
									Solar UV survey - S	V. H. Regener	U. of N. Mexico	
									Sodium day-glow-R	J. E. Blamont	U. of Paris	
									Celestial lyman alpha-R	M. A. Clark	Aerospace	
									U. V. photometer-R	C. A. Barth	U. of Colo.	
									Airglow and aurora photograph-R	J. E. Blamont	U. of Paris	
									Fabry-perot interferometer-R	J. E. Blamont	U. of Paris	
									Auroral particles-E	D. S. Evans	GSFC	
									Trapped and precipitating electrons-E	R. A. Farley	UCLA	
									Trapped and precipitating electrons-E	D. J. Williams	GSFC	
									Neutron monitor-E	J. A. Lockwood	U. of N. Hampshire	
									Solar cosmic rays - E	A. J. Masley	Douglas	
									Solar and galactic cosmic rays-E	E. C. Stone	C. I. T.	
									Magnetic field measurements-E	J. C. Cain	GSFC	
									Search coil magnetometer-E	E. J. Smith	JPL	
									Electron field measurements-E	T. Aggson	GSFC	
									VLF measurements-I	R. A. Helliwell	Stanford U.	
									Whistler mode wave - I	T. Laaspere	Darmouth	
ORBITING SOLAR OBSERVATORY OSO-F	To conduct experiments in solar physics above the earth's atmosphere; experiments will detect and measure electromagnetic radiation from the sun, and celestial sphere, and determine its energy level.	1968	Delta ETR	95.73	345 circular orbit		Laurence T. Hogarth	Stabilized platform for solar-oriented scientific instruments. Experiments not requiring fixed orientation with respect to the sun are housed in the spinning wheel section of the satellite. Electrical power is supplied by an array of solar cells mounted on the stabilized section. A complete telemetry system is provided to transmit information back to	POINTED			Weight: Estimated 575 lb. (300 for spacecraft and 245 for experiments) Power: Solar Inclination: 32.91°
									X-ray spectroheliograph 3-9A and 8-18A - S	R. L. F. Boyd A. P. Willmore K. A. Pounds	U. College, London and U. of Leicester	
									Extreme ultraviolet solar spectroheliograph, HeI 1216A; HeII 304A; NeVII 405A; FeXV 335A; SiXII 499A	J. D. Purcell C. R. Detwiler R. Tousey	NRL	
									Continuation of the studies of solar spectrum 1 - 400A - S	W. Neupert	GSFC	

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PART II
SCHEDULED SATELLITE PROJECTS, PARTIAL LISTING (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA: Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles: Perigee	Apogee	Project Manager and Project Scientist	EXPERIMENT DATA: Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	Remarks
ORBITING SOLAR OBSERVATORY OSO-F (Continued)								earth. Spacecraft has pointing and scanning capability to OSO-B2.	WHEEL			
									Measurement of self-reversal of the solar Lyman-alpha line – S	J. E. Blamont	U. of Paris	
									Solar X-ray radiation ion-chamber photometer, monitoring experiments 0.5 – 3A, 2-8A, 8-16A and 44 – 60A – S	T. A. Chubb R. W. Kreplin H. Friedman	NRL	
									Low-energy gamma-ray region 2 – 200 kev – S	K. J. Frost H. Hortsman E. Rothe	GSFC	
									Zodiacal light monitoring, measuring intensity and polarization of the zodiacal light.	E. P. Ney	U. of Minnesota	
									Solar far ultraviolet radiation monitoring in three EUV bands 280 – 370A, 465 – 630A, and 760 – 1030A	W. A. Rense R. Parker	U. of Colorado	
ORBITING SOLAR OBSERVATORY OSO-G	To conduct experiments in solar physics above the earth's atmosphere; experiments will detect and measure electromagnetic radiation from the sun and determine its energy level.	1968	Delta ETR	95	345 circular orbit		Laurence T. Hogarth		POINTED			
									Spectrometer – spectroheliometer 300A – 1300A	L. Goldberg E. M. Reeves W. H. Parkinson	Harvard College Observatory	
									Spectral burst, and mapping measurement solar x-rays	R. W. Kreplin T. A. Chubb J. F. Meekins H. Friedman	NRL	
									WHEEL			
									Study of He I, He II, 0 and N radiation	R. L. F. Boyd B. E. Woodgate	U. College London	
									Solar x-ray monitoring in the 16 – 40A region	H. V. Argo J. A. Bergey W. D. Evans B. L. Henke	Los Alamos Scientific Laboratory	
									Study of the zodiacal light	A. L. Rouy B. Carroll L. H. Aller	Rutgers U.	
									Solar x-ray monitoring in the 20 – 200 kev energy range	D. Brini M. Galli D. Cattani U. Ciriegi F. Fuligni D. Moretti	U. of Bologna	
									Measure direction and energies of high-energy neutron fluxes	C. P. Leavitt	U. of New Mexico	

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PART II
SCHEDULED SATELLITE PROJECTS, PARTIAL LISTING (Cont.)

Designation	Objectives	LAUNCH AND ORBIT DATA					Project Manager and Project Scientist	EXPERIMENT DATA				Remarks
		Launch Date/ Silent Date	Vehicle & Launch Site	Period (Min.)	Statute Miles			Instrumentation Summary	Experiment and Discipline*	Experimenter	Affiliation	
					Perigee	Apogee						
RAE-B (Radio Astronomy Sat.)	Investigation of low frequency emissions from our sun, its planets, galactic and extragalactic sources.	1968	Improved TAD WTR	228	3728	3728	J. Shea Dr. R. Stone	Step-frequency (Ryle-Vonberg) Radiometers (4)	Basic Radio Astronomy Experiment	Dr. R. G. Stone and J. Alexander		
								Rapid Burst Receivers	Solar burst measurements	Dr. R. G. Stone and J. Alexander		
								Impedance Probes (2)	Antenna Calibration	Dr. R. G. Stone and J. Alexander		
								Capacitance Probe	Antenna Calibration	Dr. R. G. Stone and J. Alexander		
								Electron Probe	Measurement of the satellite/plasma potential and electron density.	Dr. R. G. Stone and J. Alexander		
TOS-H (Tiros Operational Sat.)		1968	Improved TAD WTR				W. W. Jones					
TIROS-M		1968	Improved TAD WTR				W. W. Jones					

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PART III
NASA SOUNDING ROCKET FLIGHTS THROUGH OCTOBER 1966

NOTES

1. Numbering System:

NASA

1. AEROBEE 100
2. ARCON
3. NIKE ASP
4. AEROBEE 150, 150A
5. IRIS
6. AEROBEE 300
7. ARGO E-5
8. ARGO D-4
9. SKYLARK
10. NIKE CAJUN
11. ARGO D-8
12. SPECIAL PROJECTS
14. NIKE APACHE
15. ARCAS
16. ASTROBEE 1500
17. AEROBEE 350
18. NIKE TOMAHAWK

2. Identifying letters: The letters which follow each rocket number identify

(1) the instrumenting agency, and
(2) the experiment according to the following list:

AGENCY

G – Goddard
N – Other NASA Centers
U – College or University
D – DOD
A – Other Government Agency
C – Industrial Corporations
I – International

EXPERIMENT

A – Aeronomy
M – Meteorology
E – Energetic Particles and Fields
I – Ionospheric Physics
S – Solar Physics
G – Galactic Astronomy
R – Radio Astronomy
B – Biological
P – Special Projects
T – Test and Support

FIRING SITES

ARG – Chamical Argentina
ASC – Ascension Island
AUS – Woomera, Australia
BRZ – Natal, Brazil
EGL – Eglin Air Force Base, Florida
FC – Fort Churchill, Canada
IND – Thumba, India
Italy – Sardinia, Italy
NOR – Andoya, Norway
NZ – Karikari, New Zealand
PB – Point Barrow, Alaska
PMR – Pacific Missile Range
PAK – Karachi, Pakistan
SWE – Kronogard, Sweden
SUR – Coronie, Surinam
WI – Wallops Island, Virginia
WS – White Sands Missile Range, New Mexico

ABBREVIATIONS

AFCRL	Air Force Cambridge Research Laboratories, Bedford, Mass.
Ames	NASA, Ames Research Center, Moffett Field, Calif.
AS&E	American Science and Engineering, Inc., Cambridge, Mass.
BRL	Ballistics Research Laboratories, Aberdeen, Md.
BuStds	National Bureau of Standards, Boulder, Colo.
CRPL	Central Radio Propagation Laboratories, National Bureau of Standards, Boulder, Colo.
AIL	Airborne Instruments Laboratory, New York
DRTE	Canadian Defense Research Telecommunications Establishment, Ottawa, Canada
GCA	Geophysics Corporation of America, Bedford, Mass.
NRL	Naval Research Laboratory, Washington, D.C.
U. Colo.	University of Colorado, Boulder, Colo.
U. Ill.	University of Illinois, Urbana, Ill.
U. Mich.	University of Michigan, Ann Arbor, Mich.
UNH	University of New Hampshire, Durham, N. H.
U. Pitt	University of Pittsburgh, Pittsburgh, Pa.
U. Wisc.	University of Wisconsin, Madison, Wisc.
Varian	Varian Associates, Palo Alto, Calif.
Harvard	Harvard College, Cambridge, Mass.
JHU	Johns Hopkins University, Baltimore, Md.
JPL	Jet Propulsion Laboratory, Pasadena, Calif.
LaRC	NASA, Langley Research Center, Hampton, Va.
LeRC	NASA, Lewis Research Center, Cleveland, Ohio
Lockheed	Lockheed Missiles and Space Division, Palo Alto, Calif.
U. Minn.	University of Minnesota, Minneapolis, Minn.
NYU	New York University, New York, N.Y.
Penn State	Penn State University, University Park, Pa.
Princeton	Princeton University, Princeton, N. J.
SCAS	Southwest Center for Advanced Studies, Dallas, Texas
Rice	Rice University, Houston, Texas

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
				AERONOMY			
	1960						
4.09 GA	Apr. 29	WI	S	Horowitz, GSFC	Horowitz, GSFC	Atmospheric Composition	S
10.03 GA	June 16	WI	P	Nordberg, GSFC	Nordberg, GSFC	Grenade	X
10.04 GA	July 9	WI	S	Nordberg, GSFC	Nordberg, GSFC	Grenade	S
10.01 GA	14	WI	S	Nordberg, GSFC	Nordberg, GSFC	Grenade	X
4.14 GA	Nov. 15	WI	S	Taylor, GSFC	Taylor, GSFC	Atmospheric Composition	S
10.06 GA	Dec. 14	WI	S	Nordberg, GSFC	Nordberg, GSFC	Grenade	S
	1961						
10.07 GA	Feb. 14	WI	S	Nordberg, GSFC	Nordberg, GSFC	Grenade	S
10.08 GA	17	WI	P	Nordberg, GSFC	Nordberg, GSFC	Grenade	S
10.33 GA	Apr. 5	WI	S	Nordberg, GSFC	Nordberg, GSFC	Grenade	P
10.34 GA	27	WI	X	Smith, GSFC	Smith, GSFC	Grenade	X
10.02 GA	May 5	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.28 GA	6	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.29 GA	9	WI	S	Smith, GSFC	Smith, GSFC	Grenade	P
10.30 GA	July 13	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.31 GA	14	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.32 GA	20	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.35 GA	21	WI	S	Smith, GSFC	Smith, GSFC	Grenade	X
10.36 GA	Sep. 16	WI	P	Smith, GSFC	Smith, GSFC	Grenade	P
10.37 GA	17	WI	S	Smith, GSFC	Smith, GSFC	Grenade	X
1.08 GA	23	FC	S	Varian Associates	Martin, GSFC	Atmospheric Structure	S
1.09 GA	30	FC	S	Varian Associates	Martin, GSFC	Atmospheric Structure	S
8.23 GA	Oct. 10	WI	S	Taylor, GSFC	Taylor, GSFC	Ionosphere	S
1.10 GA	15	FC	S	Varian Associates	Martin, GSFC	Atmospheric Structure	S
1.07 GA	17	FC	S	Varian Associates	Martin, GSFC	Atmospheric Structure	S
1.11 GA	Nov. 2	FC	S	Varian Associates	Martin, GSFC	Atmospheric Structure	S
1.12 GA	5	FC	S	Varian Associates	Martin, GSFC	Atmospheric Structure	S
10.64 GA	Dec. 21	WI	S	U. Mich.	Spencer, GSFC	Atmospheric Structure	S
	1962						
10.38 GA	Mar. 2	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.39 GA	2	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
4.18 GA	19	WI	X	U. Mich.	Spencer, GSFC	Atmospheric Structure	X
10.40 GA	23	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.41 GA	28	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.42 GA	Apr. 17	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
5.04 GA	May 3	WI	P	Taylor, GSFC	Taylor, GSFC	Atmospheric Structure	S
10.43 GA	June 7	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.44 GA	8	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.65 GA	Nov. 16	FC	X	Smith, GSFC	Smith, GSFC	Grenade	X
6.06 GA	20	WI	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
10.45 GA	Dec. 1	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.68 GA	1	FC	S	Smith, GSFC	Smith, GSFC	Grenade	X
10.46 GA	4	WI	S	Smith, GSFC	Smith, GSFC	Grenade	X
10.67 GA	4	FC	X	Smith, GSFC	Smith, GSFC	Grenade	S
10.47 GA	6	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.66 GA	6	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
	1963						
10.48 GA	Feb. 20	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.58 GA	20	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S

* S–Successful
P–Partial Success
X–Unsuccessful
– – Subject to Interpretation

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
10.53 GA	Feb. 28	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.59 GA	28	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.54 GA	Mar. 9	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.60 GA	9	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
6.07 GA	Apr. 18	WI	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
10.55 GA	Dec. 7	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
	1964						
10.61 GA	Jan. 24	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.86 GA	24	FC	X	Smith, GSFC	Smith, GSFC	Grenade	X
6.09 GA	29	WI	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
10.71 GA	29	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.89 GA	29	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.81 GA	29	ASC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.62 GA	Feb. 4	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.87 GA	5	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.63 GA	5	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.136 GA	13	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.82 GA	13	ASC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.88 GA	13	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.137 GA	Mar. 7	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.73 GA	Apr. 18	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.83 GA	18	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
4.113 GA-GI	21	WS	X	Berg-Aikin, GSFC	Berg-Aikin, GSFC	Astrochemistry and Ionospheres	X
6.10 GA	July 28	FC	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
10.114 GA	Aug. 5	ASC	S	Smith, GSFC	Smith, GSFC	Grenade	X
10.138 GA	7	SWE	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.78 GA	7	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.104 GA	8	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.139 GA	12	SWE	S	Smith, GSFC	Smith, GSFC	Grenade	X
10.84 GA	12	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.105 GA	12	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.140 GA	16	SWE	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.85 GA	16	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.115 GA	16	ASC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.116 GA	16	ASC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.141 GA	17	SWE	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.106 GA	18	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.113 GA	18	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.132 GA	Nov. 3	WI	S	Smith, GSFC	Smith, GSFC	Grenade	X
10.107 GA	5	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.133 GA	6	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.134 GA	6	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.135 GA	6	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
4.45 GA	16	WI	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
10.117 GA	19	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
4.83 GA	Dec. 1	WI	S	Hennes, GSFC	Hennes, GSFC	Middle UV Airglow	S
4.132 GA-GI	16	WI	S	Berg, GSFC	Berg, GSFC	Micrometeorites	S
	1965						
10.124 GA	Jan. 27	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.121 GA	27	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.118 GA	27	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.125 GA	Feb. 4	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.119 GA	4	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.122 GA	4	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S

* S–Successful
P–Partial Success } – – Subject to Interpretation
X–Unsuccessful

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING DATE	FIRING SITE	FIRING PERF*	EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
10.126 GA	Feb. 8	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.120 GA	8	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.123 GA	8	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
12.05 GA**	Mar. 19	WI	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
6.11 GA	20	WI	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
10.150 GA	Apr. 28	PB	S	Smith, GSFC	Smith, GSFC	Grenade	X
10.127 GA	May 3	WI	S	Smith, GSFC	Smith, GSFC	Grenade	X
4.150 GA-GI-GB	Sep. 28	WS	S	Berg, GSFC	Berg, GSFC	Micrometeorite, Iono, Microorganisms	S
18.03 GA	Nov. 9	FC	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
18.02 GA	10	FC	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
	1966						
8.25 GA-GI	Mar. 2	WI	S	Smith, GSFC	Smith, GSFC	Geoprobe	S
18.05 GA	Aug. 26	WI	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
18.06 GA	26	WI	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
18.22 GA	28	WI	S	U. Mich.	Brace, GSFC	Thermosphere Probe	S
	1961						
10.72 NA	Nov. 18	WI	S	LaRC	Hord, LaRC	Airglow	S
	1962						
10.79 NA	Apr. 5	WI	S	LeRC	Potter, LeRC	Ozone	S
1.13 NA	Sep. 6	WI	S	JPL	Dubin, HQ	U. V. Airglow	S
1.14 NA	Nov. 20	WI	X	JPL	Dubin, HQ	U. V. Airglow	X
	1963						
10.80 NA	Jan. 17	WI	S	LeRC	Potter, LeRC	Ozone	S
10.92 NA	Sep. 25	WI	S	LaRC	LaRC	Chemical Release	S
10.93 NA	25	WI	S	LaRC	LaRC	Chemical Release	S
14.102 NA	Oct. 9	WI	S	LeRC	Potter, LeRC	Chemical Release	S
14.103 NA	10	WI	S	LeRC	Potter, LeRC	Chemical Release	S
4.85 NA	Nov. 18	WI	S	JPL	Dubin, HQ	Airglow	S
	1964						
4.86 NA	Apr. 14	WS	X	JPL	Dubin, HQ	Airglow	X
4.115 NA	Sep. 18	WI	S	JPL	Dubin, HQ	Dayglow	S
4.118 NA	Nov. 16	WI	S	Ames	Ames	Micrometeroid	X
	1965						
14.142 NA	Jan. 7	WI	S	LeRC	Potter, LeRC	Airglow	P
4.111 NA	13	WI	S	JPL	Dubin, HQ	Airglow	S
14.132 NA	Apr. 1	WI	S	LeRC	Potter, LeRC	Airglow	S
10.171 NA	23	WI	S	LaRC	Tolefson, LaRC	Chemiluminescent Cloud	S
14.255 NA	23	WI	S	LaRC	Tolefson, LaRC	Chemiluminescent Cloud	S
4.112 NA	June 29	WS	S	JPL	Dubin, HQ	Airglow	S
14.133 NA	Aug. 19	WI	S	LeRC	Potter, LeRC	Airglow	X
4.142 NA	Oct. 19	WI	S	U. Colo.	Dubin, HQ	1965F Comet Spectra	X
4.119 NA	Nov. 16	WS	S	Ames	Ames	Micrometeorite	S

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**Nike Tomahawk

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			PRINCIPAL NASA SCIENTIST	COOPERATING INVESTIGATOR	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
	1960						
10.09 UA	Nov. 2	WI	S	U. Mich.	Dubin, HQ	Atmospheric Composition	X
10.10 UA	16	WI	S	U. Mich.	Dubin, HQ	Atmospheric Composition	X
	1961						
10.50 UA	June 6	WI	S	U. Mich.	Dubin, HQ	Atmospheric Structure	S
10.56 UA	9	WI	S	U. Mich.	Dubin, HQ	Atmospheric Composition	X
10.57 UA	July 26	WI	S	U. Mich.	Dubin, HQ	Atmospheric Composition	X
	1962						
10.90 UA	Feb. 20	WI	S	U. Mich.	Dubin, HQ	Atmospheric Composition	X
10.91 UA	May 18	WI	S	U. Mich.	Dubin, HQ	Atmospheric Composition	S
14.19 UA	June 6	WI	S	U. Mich.	Spencer, GSFC	Atmospheric Structure	S
14.20 UA	Dec. 1	WI	S	U. Mich.	Spencer, GSFC	Atmospheric Structure	S
4.74 UA	13	WI	X	JHU	Dubin, HQ	Airglow	X
	1963						
4.73 UA	Jan. 29	WI	X	JHU	Dubin, HQ	Airglow	X
14.08 UA	Mar. 28	WI	S	U. Mich.	Dubin, HQ	Atmospheric Composition	S
14.09 UA	28	WI	S	U. Mich.	Dubin, HQ	Atmospheric Composition	X
4.98 UA	May 7	WI	S	JHU	Dubin, HQ	Airglow	S
4.75 UA	July 20	FC	X	JHU	Dubin, HQ	Airglow	X
10.75 UA	Aug. 2	WI	S	U. Mich.	Holtz, HQ	Atmospheric Density	S
4.76 UA	Nov. 12	WI	S	JHU	Dubin, HQ	Airglow	S
14.10 UA	26	WI	S	U. Mich.	Dubin, HQ	Atmospheric Composition	S
10.131 UA	26	WI	S	U. Mich.	Dubin, HQ	Atmospheric Density	S
14.21 UA	Dec. 7	WI	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
	1964						
14.22 UA	Feb. 4	ASC	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
4.124 UA	Feb. 27	FC	P	JHU	Dubin, HQ	Aurora	S
14.24 UA	Apr. 15	ASC	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
14.23 UA	15	ASC	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
10.142 UA	17	WI	S	U. Mich.	Dubin, HQ	Atmospheric Density	S
8.34 UA	Nov. 5	WI	S	JHU	Dubin, HQ	Airglow	S
14.233 UA	17	SHIP	S	U. Mich.	Dubin, HQ	Atmospheric Density	S
10.153 UA	17	SHIP	S	U. Mich.	Dubin, HQ	Atmospheric Density	S
14.29 UA	19	SHIP	X	U. Mich.	Smith, GSFC	Pitot Probe	X
4.125 UA	Dec. 17	WI	S	JHU	Dubin, HQ	Airglow	S
	1965						
14.11 UA	Feb. 18	FC	S	U. Mich.	Dubin, HQ	Composition	S
4.129 UA	19	FC	S	JHU	Dubin, HQ	Auroral Studies	S
14.95 UA	19	FC	S	U. Mich.	Dubin, HQ	Composition	S
10.155 UA	26	SHIP	S	U. Mich.	Dubin, HQ	Air Density	S
14.64 UA	Mar. 8	SHIP	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
14.65 UA	9	SHIP	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
14.98 UA	11	SHIP	S	U. Mich.	Dubin, HQ	Composition	S
10.156 UA	11	SHIP	S	U. Mich.	Dubin, HQ	Air Density	S
14.99 UA	11	SHIP	S	U. Mich.	Dubin, HQ	Composition	S
14.62 UA	18	WI	S	SCAS	Horowitz, HQ	Composition	P

*S–Successful
P–Partial Success } - - Subject to Interpretation
X–Unsuccessful

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
14.66 UA	Apr. 4	SHIP	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
14.26 UA	6	SHIP	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
14.63 UA	9	SHIP	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
14.27 UA	13	SHIP	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
14.101 UA	13	SHIP	S	U. Mich.	Dubin, HQ	Composition	X
4.127 UA	15	WS	S	Minn.	Dubin, HQ	Composition	S
14.100 UA	15	SHIP	S	U. Mich.	Dubin, HQ	Composition	X
14.25 UA	15	SHIP	S	U. Mich.	Smith, GSFC	Atmospheric Structure	S
14.47 UA	May 22	ASC	S	U. Mich.	Smith, GSFC	Pitot Probe	S
14.48 UA	22	ASC	S	U. Mich.	Smith, GSFC	Pitot Probe	S
4.128 UA	July 15	WS	S	U. Minn.	Dubin, HQ	Composition	S
10.154 UA	Aug. 7	WI	S	U. Mich.	Dubin, HQ	Air Density	S
10.157 UA	8	WI	S	U. Mich.	Dubin, HQ	Air Density	S
10.144 UA	11	WS	S	Dudley Obs.	Dubin, HQ	Micrometeorite	X
8.11 UA	25	WI	S	U. Pitt.	Dubin, HQ	Helium Ionization	S
4.164 UA	Oct. 21	WI	S	JHU	Dubin, HQ	1965F Comet Spectra	S
14.78 UA	Nov. 18	WS	S	Dudley Obs.	Dubin, HQ	Micrometeorite	S
	1966						
10.158 UA	Jan. 25	WI	S	U. Mich.	Dubin, HQ	Air Density	S
10.159 UA	Feb. 3	WI	S	U. Mich.	Dubin, HQ	Air Density	S
10.143 UA	4	WI	S	U. Mich.	Dubin, HQ	Air Density	S
4.162 UA	20	FC	S	JHU	Dubin, HQ	Auroral Physics	P
4.143 UA	Apr. 14	WS	S	U. Colo.	Dubin, HQ	Dayglow	S
4.165 UA	21	WS	S	JHU	Dubin, HQ	Planetary UV	P
14.96 UA	July 11	FC	S	U. Mich.	Dubin, HQ	Atmospheric Composition	S
8.12 UA	12	WI	S	U. Pitt.	Dubin, HQ	Atmospheric Composition	S
14.170 UA	Aug. 16	WS	S	Dudley Obs.	Dubin, HQ	Micrometeorite	X
	1963						
14.140 DA	May 18	EGL	S	AFCRL	Dubin, HQ	Sodium Vapor	S
14.141 DA	18	EGL	S	AFCRL	Dubin, HQ	Sodium Vapor	S
10.130 DA	22	EGL	S	AFCRL	Dubin, HQ	Sodium Vapor	S
	1964						
8.31 DA	Jan. 17	WI	S	NRL	Dubin, HQ	Composition Airglow	S
14.54 DA	May 28	WI	X	ARCRL	Smith, GSFC	Air Sampling	X
14.55 DA	Aug. 6	SWE	S	AFCRL	Smith, GSFC	Air Sampling	X
14.56 DA	12	SWE	S	AFCRL	Smith, GSFC	Air Sampling	S
14.57 DA	16	SWE	S	AFCRL	Smith, GSFC	Air Sampling	S
14.58 DA	17	SWE	S	AFCRL	Smith, GSFC	Air Sampling	S
	1966						
8.32 DA	Aug. 15	WI	S	NRL	Dubin, HQ	Atmospheric Composition	S
	1962						
14.45 AA	Dec. 1	EGL	S	AFCRL	Dubin, HQ	Sodium Vapor	X
14.46 AA	3	EGL	S	AFCRL	Dubin, HQ	Sodium Vapor	P
	1959						
3.13 CA	Aug. 17	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
3.14 CA	19	WI	X	GCA	Dubin, HQ	Sodium Vapor	X

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
3.15 CA	Nov. 18	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
3.16 CA	19	WI	S	GCA	Dubin, HQ	Sodium Vapor	X
3.17 CA	20	WI	S	GCA	Dubin, HQ	Sodium Vapor	X
	1960						
3.23 CA	May 24	WI	X	GCA	Dubin, HQ	Sodium Vapor	X
3.24 CA	25	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
10.05 GA	Sep. 20	WI	S	Nordberg, GSFC	Nordberg, GSFC	Grenade	X
8.04 CA	Nov. 10	WI	S	Lockheed	Dubin, HQ	Ionosphere	P
10.11 CA	Dec. 9	WI	X	GCA	Dubin, HQ	Sodium Vapor	X
10.12 CA	9	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
8.05 CA	10	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
	1961						
3.05 CA	Apr. 19	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
3.06 CA	21	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
3.07 CA	21	WI	X	GCA	Dubin, HQ	Sodium Vapor	X
3.08 CA	21	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
8.06 CA	Sep. 13	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
8.22 CA	13	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
3.09 CA	16	WI	X	GCA	Smith, GSFC	Sodium Vapor	X
3.18 CA	16	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
3.19 CA	17	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
	1962						
10.100 CA	Mar. 1	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
10.101 CA	2	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
10.102 CA	23	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
10.103 CA	27	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
3.20 CA	Apr. 17	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
3.21 CA	June 7	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
3.22 CA	7	WI	X	GCA	Smith, GSFC	Sodium Vapor	X
14.30 CA	Aug. 23	WI	P	Lockheed	Depew, GSFC	Atmospheric Structure	X
14.16 CA	Nov. 7	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.17 CA	30	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.18 CA	Dec. 5	WI	S	GCA	Smith, GSFC	Sodium Vapor	P
	1963						
3.11 CA	Feb. 18	WI	X	GCA	Smith, GSFC	Sodium Vapor	X
14.35 CA	20	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.39 CA	21	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.110 CA	May 8	WI	S	Lockheed	Bourdeau, GSFC	Massenfilter	X
14.13 CA	22	FC	S	GCA	Dubin, HQ	Sodium Vapor	S
14.14 CA	22	FC	S	GCA	Dubin, HQ	Sodium Vapor	S
14.15 CA	23	FC	S	GCA	Dubin, HQ	Sodium Vapor	S
14.40 CA	24	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
14.41 CA	24	WI	S	GCA	Dubin, HQ	Sodium Vapor	X
14.42 CA	25	WI	S	GCA	Dubin, HQ	Sodium Vapor	S
	1964						
14.38 CA	Jan. 15	WI	X	GCA	Smith, GSFC	Sodium Vapor	X
14.106 CA	15	WI	P	GCA	Smith, GSFC	Sodium Vapor	S
14.125 CA	16	WI	S	GCA	Smith, GSFC	Sodium Vapor	S

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X–Unsuccessful

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
14.126 CA	Jan. 16	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.49 CA	July 15	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.50 CA	15	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.51 CA	15	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.52 CA	15	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.195 CA	Oct. 7	WI	S	GCA	Dubin, HQ	Luminous Cloud Ionospheres	S
8.03 CA	8	WI	S	Lockheed	Dubin, HQ	Ion Composition	S
14.194 CA	8	WI	S	GCA	Dubin, HQ	Luminous Cloud Ionospheres	S
14.197 CA	Nov. 1	FC	S	GCA	Dubin, HQ	Luminous Cloud Ionospheres	S
14.114 CA	10	SHIP	S	GCA	Smith, GSFC	Sodium Vapor	S
14.53 CA	10	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.115 CA	11	SHIP	S	GCA	Smith, GSFC	Sodium Vapor	S
14.112 CA	11	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.116 CA	12	SHIP	S	GCA	Smith, GSFC	Sodium Vapor	S
14.113 CA	12	WI	S	GCA	Smith, GSFC	Sodium Vapor	X
	1965						
14.196 CA	Feb. 28	FC	S	GCA	Dubin, HQ	Ionospheres-Luminescent Cloud	S
14.198 CA	28	FC	X	GCA	Dubin, HQ	Ionospheres-Luminescent Cloud	X
14.199 CA	28	FC	X	GCA	Dubin, HQ	Ionospheres-Luminescent Cloud	X
14.200 CA	28	FC	X	GCA	Dubin, HQ	Ionospheres-Luminescent Cloud	X
14.201 CA	June 23	WI	S	GCA	Dubin, HQ	Ionospheres-Luminescent Cloud	S
14.202 CA	Oct. 5	FC	S	GCA	Dubin, HQ	Ionospheres-Luminescent Cloud	S
14.203 CA	6	FC	X	GCA	Dubin, HQ	Ionospheres-Luminescent Cloud	X
	1963						
10.77 IA	May 16	PAK	S	Pakistan	Dubin, HQ	Sodium Vapor	X
14.137 IA	20	Italy	S	Italy	Dubin, HQ	Sodium Vapor	S
14.138 IA	21	Italy	S	Italy	Dubin, HQ	Sodium Vapor	S
14.139 IA	21	Italy	S	Italy	Dubin, HQ	Sodium Vapor	S
14.128 IA	Nov. 21	IND	S	India	Dubin, HQ	Sodium Vapor	P
	1964						
14.129 IA	Jan. 8	IND	S	India	Dubin, HQ	Sodium Vapor	S
14.130 IA	12	IND	S	India	Dubin, HQ	Sodium Vapor	S
14.134 IA	Apr. 9	PAK	S	Pakistan	Dubin, HQ	Sodium Vapor	X
14.131 IA	Nov. 6	IND	S	India	Dubin, HQ	Sodium Vapor	S
14.204 IA	9	IND	S	India	Dubin, HQ	Sodium Vapor	S
14.205 IA	10	IND	S	India	Dubin, HQ	Sodium Vapor	S
14.135 IA	30	PAK	S	Pakistan	Dubin, HQ	Sodium Vapor	S
14.136 IA	Dec. 1	PAK	S	Pakistan	Dubin, HQ	Sodium Vapor	S
	1965						
14.253 IA	Mar. 1	NOR	S	Sweden	Dubin, HQ	Discharge of TNT	S
14.254 IA	3	NOR	S	Sweden	Dubin, HQ	Discharge of TNT	S
14.224 IA	Sep. 18	Surinam	S	Netherlands	Dubin, HQ	Sodium Vapor	S
14.225 IA	21	Surinam	S	Netherlands	Dubin, HQ	Sodium Vapor	S
14.226 IA	24	Surinam	S	Netherlands	Dubin, HQ	Sodium Vapor	S
14.227 IA	27	Surinam	S	Netherlands	Dubin, HQ	Sodium Vapor	S
	1966						
14.211 IA	Feb. 25	PAK	S	Pakistan	Dubin, HQ	Sodium Vapor	S
14.212 IA	26	PAK	S	Pakistan	Dubin, HQ	Sodium Vapor	X

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X–Unsuccessful
} – – *Subject to Interpretation*

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
14.257 IA	Mar. 24	IND	S	India	Dubin, HQ	Sodium Vapor	X
14.258 IA	25	IND	S	India	Dubin, HQ	Sodium Vapor	X
	1962						
Rehbar 1**	June 7	PAK	S	Pakistan	Dubin, HQ	Sodium Vapor	X
Rehbar 2**	11	PAK	S	Pakistan	Dubin, HQ	Sodium Vapor	X
				METEOROLOGY			
	1965						
10.128 GM	July 23	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.151 GM	Aug. 7	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.96 GM	7	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.162 GM	7	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.165 GM	7	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.168 GM	7	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.169 GM	8	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.166 GM	8	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.163 GM	8	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.167 GM	8	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.170 GM	8	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.164 GM	9	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.152 GM	Oct. 13	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.97 GM	13	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
0.129 GM	13	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.177 GM	19	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.98 GM	19	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.174 GM	19	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.178 GM	23	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.175 GM	23	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.172 GM	23	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.176 GM	27	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.179 GM	27	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.173 GM	27	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
	1966						
10.185 GM	Jan. 24	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.182 GM	Feb. 1	PB	S	Smith, GSFC	Smith, GSFC	Grenade	P
10.147 GM	1	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.186 GM	2	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.187 GM	10	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.148 GM	10	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.183 GM	10	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.145 GM	10	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.149 GM	10	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.184 GM	10	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.190 GM	May 1	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.188 GM	2	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.194 GM	2	BRAZ	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.192 GM	2	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.191 GM	3	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.193 GM	4	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.189 GM	4	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.195 GM	4	BRAZ	S	Smith, GSFC	Smith, GSFC	Grenade	S

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X–Unsuccessful

**Nike Cajun

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
10.198 GM	June 17	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.196 GM	17	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.199 GM	23	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.197 GM	23	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
14.296 GM	Aug. 7	WI	P	Smith, GSFC	Smith, GSFC	Grenade	S
10.204 GM	7	BRAZ	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.202 GM	7	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.203 GM	7	FC	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.206 GM	7	WI	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.205 GM	7	BRAZ	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.200 GM	14	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
10.201 GM	14	PB	S	Smith, GSFC	Smith, GSFC	Grenade	S
4.156 GM	29	WS	S	Heath, GSFC	Heath, GSFC	Airglow and Electron Temperature and Density	S
	1965						
14.71 CM	June 23	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.72 CM	23	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.73 CM	23	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.74 CM	23	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
	1966						
14.262 CM	Jan. 17	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.263 CM	18	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.264 CM	18	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.265 CM	18	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.266 CM	18	WI	S	GCA	Smith, GSFC	Sodium Vapor	S
14.291 CM	July 17	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.292 CM	17	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.293 CM	17	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.294 CM	17	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
14.295 CM	17	WI	S	GCA	Smith, GSFC	Luminescent Cloud	S
	1966						
10.180 IM	Mar. 24	PAK	S	G. Britain-Pakistan	Spreen, HQ	Grenade	S
14.249 IM	Apr. 26	PAK	S	G. Britain-Pakistan	Spreen, HQ	Grenade-Chemical Release	P
	1965						
14.168 UM	Nov. 9	FC	S	U. Mich.	Smith, GSFC	Atmosphere Structure	S
14.169 UM	10	FC	X	U. Mich.	Smith, GSFC	Atmosphere Structure	X
	1966						
14.251 UM	Feb. 27	ASC	S	U. Mich.	Smith, GSFC	Atmosphere Structure	S
14.252 UM	28	ASC	X	U. Mich.	Smith, GSFC	Atmosphere Structure	X
14.289 UM	Aug. 7	FC	S	U. Mich.	Smith, GSFC	Atmosphere Structure	S
14.285 UM	26	WI	S	U. Mich.	Smith, GSFC	Atmosphere Structure	S
14.286 UM	28	WI	S	U. Mich.	Smith, GSFC	Atmosphere Structure	S

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
				ENERGETIC PARTICLES AND FIELDS			
	1960						
10.17 GE	June 6	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
8.07 GE	30	WI	X	Heppner, GSFC	Heppner, GSFC	Magnetic Field	S
10.18 GE	July 22	FC	X	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.19 GE	Sep. 3	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.20 GE	3	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
11.01 GE	19	PMR	S	Naugle, GSFC	Naugle, GSFC	NERV 1	S
10.21 GE	27	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.22 GE	Nov. 11	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.23 GE	11	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	P
10.24 GE	12	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.15 GE	12	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.16 GE	13	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.13 GE	16	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.14 GE	17	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.26 GE	18	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
10.27 GE	18	FC	S	Fichtel, GSFC	Fichtel, GSFC	SBE	S
8.08 GE	Dec. 12	WI	S	Heppner, GSFC	Heppner, GSFC	Magnetic Fields	S
	1961						
10.76 GE	Dec. 10	FC	S	Ogilvie-Fichtel, GSFC	Ogilvie-Fichtel, GSFC	Cosmic Ray	S
	1963						
4.91 GE	Sep. 4	FC	S	Fichtel, GSFC	Fichtel, GSFC	Heavy Cosmic Rays	S
	1964						
14.43 GE	Feb. 20	FC	S	Evans, GSFC	Evans, GSFC	Aurora	P
14.44 GE	29	FC	S	Evans, GSFC	Evans, GSFC	Aurora	P
14.118 GE	Mar. 24	FC	S	Evans, GSFC	Evans, GSFC	Aurora	S
14.120 GE	25	FC	S	Evans, GSFC	Evans, GSFC	Aurora	X
14.119 GE	26	FC	S	Evans, GSFC	Evans, GSFC	Aurora	P
14.155 GE	June 10	WI	S	Davis, GSFC	Davis, GSFC	Magnetic Fields	S
14.156 GE	25	WI	S	Davis, GSFC	Davis, GSFC	Magnetic Fields	S
14.157 GE	26	WI	S	Davis, GSFC	Davis, GSFC	Magnetic Fields	S
4.107 GE	July 23	FC	S	Fichtel, GSFC	Fichtel, GSFC	Heavy Cosmic Rays	P
4.108 GE	25	FC	S	Fichtel, GSFC	Fichtel, GSFC	Heavy Cosmic Rays	S
14.158 GE	Oct. 7	WI	X	Davis, GSFC	Davis, GSFC	Magnetic Fields	X
14.159 GE	8	WI	S	Davis, GSFC	Davis, GSFC	Magnetic Fields	S
	1965						
14.160 GE	Mar. 8	SHIP	S	Davis, GSFC	Davis, GSFC	Magnetic Fields	S
14.171 GE	16	SHIP	S	Davis, GSFC	Davis, GSFC	Geomagnetism	S
14.172 GE	18	SHIP	S	Davis, GSFC	Davis, GSFC	Geomagnetism	S
14.174 GE	24	SHIP	S	Davis, GSFC	Davis, GSFC	Geomagnetism	S
14.173 GE	26	SHIP	S	Davis, GSFC	Davis, GSFC	Geomagnetism	S
14.175 GE	27	SHIP	S	Davis, GSFC	Davis, GSFC	Geomagnetism	S
14.70 GE	29	SHIP	S	Davis, GSFC	Davis, GSFC	Geomagnetism	S
4.140 GE	June 17	FC	S	Fichtel, GSFC	Fichtel, GSFC	Energetic Particles	S
4.141 GE	23	FC	S	Fichtel, GSFC	Fichtel, GSFC	Energetic Particles	S

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
	1966						
14.188 GE	Feb. 10	FC	S	Evans, GSFC	Evans, GSFC	Auroral Physics	S
14.189 GE	18	FC	S	Evans, GSFC	Evans, GSFC	Auroral Physics	S
14.190 GE	Mar. 14	FC	S	Evans, GSFC	Evans, GSFC	Auroral Physics	S
18.07 GE	23	FC	S	Heppner, GSFC	Heppner, GSFC	Magnetic Fields	S
18.08 GE	Apr. 14	FC	S	Heppner, GSFC	Heppner, GSFC	Magnetic Fields	S
14.218 GE	July 20	FC	S	Fichtel, GSFC	Fichtel, GSFC	SPICE	X
14.219 GE	Sep. 2	FC	S	Gus, GSFC	Gus, GSFC	SPICE	S
14.220 GE	2	FC	S	Gus, GSFC	Gus, GSFC	SPICE	S
14.221 GE	3	FC	S	Gus, GSFC	Gus, GSFC	SPICE	S
	1960						
4.16 UE	Aug. 23	WI	S	NYU	Meredith, GSFC	Cosmic Ray	S
	1961						
14.03 UE	July 14	WI	S	UNH	Heppner, GSFC	Magnetic Field	S
14.04 UE	14	WI	S	UNH	Heppner, GSFC	Magnetic Field	S
14.05 UE	20	WI	S	UNH	Heppner, GSFC	Magnetic Field	S
	1963						
11.06 UE	Feb. 12	PMR	S	U. Minn.	Cline, GSFC	Electron Spect.	S
14.06 UE	Sep. 9	WI	S	UNH	Schardt, HQ	Electrojet	S
	1964						
14.150 UE	Jan. 15	WI	P	Rice U.	Schardt, HQ	Sodium Vapor	X
14.79 UE	25	IND	S	UNH	Schardt, HQ	Equitorial Electrojet	S
14.180 UE	27	IND	S	UNH	Schardt, HQ	Equitorial Electrojet	S
14.81 UE	29	IND	S	UNH	Schardt, HQ	Equitorial Electrojet	S
14.82 UE	31	IND	S	UNH	Schardt, HQ	Equitorial Electrojet	S
14.151 UE	Mar. 18	FC	S	Rice U.	Schardt, HQ	Aurora	S
14.152 UE	20	FC	S	Rice U.	Schardt, HQ	Aurora	S
14.153 UE	23	FC	S	Rice U.	Schardt, HQ	Aurora	S
14.121 UE	Apr. 11	FC	S	Alaska	Schardt, HQ	Aurora	S
14.122 UE	15	FC	S	Alaska	Schardt, HQ	Aurora	X
14.123 UE	22	FC	S	Alaska	Schardt, HQ	Aurora	S
14.154 UE	July 9	WI	S	Rice U.	Schardt, HQ	Airglow	S
14.60 UE	Dec. 7	WI	S	UNH	Schardt, HQ	Energetic Particles	X
	1965						
14.61 UE	Feb. 3	WI	S	UNH	Schardt, HQ	Energetic Particles	S
14.85 UE	Mar. 9	SHIP	S	UNH	Opp, HQ	Magnetic Fields	S
14.83 UE	10	SHIP	S	UNH	Opp, HQ	Magnetic Fields	S
14.07 UE	12	SHIP	S	UNH	Opp, HQ	Magnetic Fields	S
14.84 UE	12	SHIP	S	UNH	Opp, HQ	Magnetic Fields	S
14.185 UE	Apr. 2	SHIP	S	UNH	Schardt, HQ	Energetic Particles	P
14.207 UE	3	FC	S	Rice U.	Schardt, HQ	Aurora	S
14.184 UE	5	SHIP	S	UNH	Schardt, HQ	Energetic Particles	P
14.186 UE	13	SHIP	S	UNH	Schardt, HQ	Energetic Particles	P
11.07 UE	14	WI	S	Minn.	Opp, HQ	Energetic Particles	X
14.234 UE	Sep. 16	FC	X	U. Cal.	Schardt, HQ	Energetic Particles	X
14.235 UE	17	FC	S	U. Cal.	Schardt, HQ	Energetic Particles	S
14.237 UE	20	FC	X	U. Cal.	Schardt, HQ	Energetic Particles	X

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} - - Subject to Interpretation

PART III

NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
14.236 UE	Sep. 20	FC	S	U. Cal.	Schardt, HQ	Energetic Particles	S
14.238 UE	Nov. 17	FC	S	Alaska	Opp, HQ	Aurora	S
14.239 UE	20	FC	S	Alaska	Opp, HQ	Aurora	S
14.124 UE	24	FC	S	Alaska	Opp, HQ	Aurora	S
14.242 UE	24	WI	S	Rice U.	Opp, HQ	Magnetic Field	S
	1966						
14.243 UE	Feb. 17	WI	S	Rice U.	Opp, HQ	Magnetic Field	S
14.183 UE	Aug. 24	FC	S	UNH	Opp, HQ	Particles and Fields	S
18.18 UE	Sep. 1	FC	S	U. Col.	Schardt, HQ	Auroral Radiation	S
18.20 UE	6	FC	S	U. Col.	Schardt, HQ	Auroral Radiation	S
18.21 UE	6	FC	S	U. Col.	Schardt, HQ	Auroral Radiation	S
	1966						
14.59 IE-II	July 7	IND	S	India	Schmerling, HQ	Magnetic Fields and Ionospheres	S
				IONOSPHERIC PHYSICS			
	1959						
4.08 GI	Sep. 11	FC	S	Jackson, GSFC	Jackson, GSFC	Ionosphere	S
4.07 GI	14	FC	S	Jackson, GSFC	Jackson, GSFC	Ionosphere	S
	1960						
1.01 GI	Nov. 23	FC	S	Whipple, GSFC	Whipple, GSFC	Ionosphere	S
1.02 GI	27	FC	S	Whipple, GSFC	Whipple, GSFC	Ionosphere	S
	1961						
8.10 GI	Apr. 27	WI	S	Jackson, GSFC	Jackson, GSFC	Ionosphere	P
8.09 GI	June 13	WI	S	Jackson, GSFC	Jackson, GSFC	Ionosphere	P
10.74 GI	Dec. 21	WI	S	Kane, GSFC	Kane, GSFC	Ionosphere	S
	1962						
10.110 GI	Apr. 26	WI	S	Serbu, GSFC	Serbu, GSFC	Electron Temperature	S
8.21 GI	May 3	WI	S	Serbu, GSFC	Serbu, GSFC	ELF Electron Trap	S
10.112 GI	16	WI	S	Serbu, GSFC	Serbu, GSFC	Electron Temperature	S
10.111 GI	17	WI	S	Serbu, GSFC	Serbu, GSFC	Electron Temperature	S
14.12 GI	June 15	WI	S	Kane, GSFC	Kane, GSFC	Ionosphere	S
K62-1**	Aug. 7	SWE	S	Sweden	Witt, Sweden	Air Sample	S
K62-3**	11	SWE	S	Sweden	Smith, GSFC	Air Sample	S
K62-4**	11	SWE	S	Sweden	Smith, GSFC	Air Sample	P
K62-5**	31	SWE	S	Sweden	Smith, GSFC	Air Sample	X
14.31 GI	Oct. 16	WI	S	Bauer, GSFC	Bauer, GSFC	Ionosphere	S
14.32 GI	Dec. 1	WI	S	Bauer, GSFC	Bauer, GSFC	Ionosphere	S
	1963						
14.107 GI	Mar. 8	WI	S	Whipple, GSFC	Whipple, GSFC	Ionosphere	P
14.108 GI	Apr. 9	WI	S	Kane, GSFC	Kane, GSFC	D-Region	S
4.44 GI	23	WI	S	Bauer, GSFC	Bauer, GSFC	Electron Density	S
8.14 GI	July 2	WI	S	Bauer, GSFC	Bauer, GSFC	Ionosphere	S
6.08 GI	20	WI	S	Brace, GSFC	Brace, GSFC	Thermosphere Probe	S

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
K63-1**	July 27	SWE	S	Sweden	Smith, GSFC	Grenade	S
K63-2**	29	SWE	S	Sweden	Smith, GSFC	Grenade	S
K63-3**	Aug. 1	SWE	S	Sweden	Smith, GSFC	Grenade	S
K63-4**	7	SWE	S	Sweden	Smith, GSFC	Heavy Cosmic Rays	S
4.65 GI	Sep. 25	WI	S	GSFC	Serbu, GSFC Hirao, Japan	Ionosphere	S
4.64 GI	28	WI	S	GSFC	Serbu, GSFC Hirao, Japan	Ionosphere	S
8.18 GI	29	WI	S	Bauer, GSFC	Bauer, GSFC	Ionosphere	
14.37 GI	Dec. 13	WI	P	Whipple, GSFC	Whipple, GSFC	Ionosphere	
	1964						
4.113 GA-GI	Apr. 21	WI	X	Berg-Aikin, GSFC	Berg-Aikin, GSFC	Ionosphere and Astrochemistry	X
14.33 GI	June 3	WI	S	Bauer, GSFC	Bauer, GSFC	Ionosphere	P
14.127 GI	July 16	WI	S	Stone, GSFC	Stone, GSFC	Ionosphere	S
14.34 GI	Aug. 26	WI	S	Bauer, GSFC	Bauer, GSFC	Ionosphere	S
8.24 GI-II	Oct. 19	WI	S	Serbu, GSFC	Serbu, GSFC	Ionosphere	P
14.117 GI	Nov. 23	WI	S	Bauer, GSFC	Bauer, GSFC	Ionosphere	S
14.209 GI	Dec. 16	WI	S	Aikin, GSFC	Aikin, GSFC	Ionosphere	S
	1965						
15.01 GI	Mar. 15	NOR	S	Kane, GSFC	Kane, GSFC	Ionospheres	X
14.177 GI	16	SHIP	S	Aikin, Blumle, GSFC	Aikin, Blumle, GSFC	Ionospheres	S
14.178 GI	18	SHIP	S	Aikin, Blumle, GSFC	Aikin, Blumle, GSFC	Ionospheres	S
14.176 GI	18	SHIP	S	Davis, GSFC	Davis, GSFC	Geomagnetism	S
14.179 GI	18	SHIP	S	Aikin, Blumle, GSFC	Aikin, Blumle, GSFC	Ionospheres	S
15.02 GI	21	NOR	S	Kane, GSFC	Kane, GSFC	Ionospheres	S
14.180 GI	24	SHIP	S	Aikin, Blumle, GSFC	Aikin, Blumle, GSFC	Ionospheres	S
14.181 GI	26	SHIP	S	Aikin, Blumle, GSFC	Aikin, Blumle, GSFC	Ionospheres	S
14.182 GI	27	SHIP	S	Aikin, Blumle, GSFC	Aikin, Blumle, GSFC	Ionospheres	S
15.18 GI	May 25	NZ	S	Kane, GSFC	Kane, GSFC	D-Region Ionospheres	S
8.37 GI	26	WI	X	Maier, GSFC	Maier, GSFC	Ionospheres	X
15.05 GI	30	NZ	S	Kane-Aikin, GSFC	Kane-Aikin, GSFC	Eclipse Ionospheres	S
15.06 GI	30	NZ	S	Kane-Aikin, GSFC	Kane-Aikin, GSFC	Eclipse Ionospheres	S
15.07 GI	30	NZ	S	Kane-Aikin, GSFC	Kane-Aikin, GSFC	Eclipse Ionospheres	S
15.08 GI	30	NZ	S	Kane-Aikin, GSFC	Kane-Aikin, GSFC	Eclipse Ionospheres	S
15.09 GI	30	NZ	S	Kane-Aikin, GSFC	Kane-Aikin, GSFC	Eclipse Ionospheres	S
15.10 GI	30	NZ	S	Kane-Aikin, GSFC	Kane-Aikin, GSFC	Eclipse Ionospheres	S
14.210 GI	Aug. 24	WI	S	Bourdeau, GSFC	Bourdeau, GSFC	Ionospheres	S
8.36 GI	Sep. 23	WI	S	Maier, GSFC	Maier, GSFC	Ionospheres	S
15.20 GI-II	Nov. 22	NOR	S	Norway	Kane, GSFC	Ionospheres	X
15.19 GI	Dec. 6	NOR	S	Kane, GSFC	Kane, GSFC	D-Region Ionospheres	S
	1966						
14.109 GI	Mar. 21	NOR	S	Kane, GSFC	Kane, GSFC	Ionospheres	S
15.25 GI	May 15	Greece	X	Kane, Aikin, GSFC	Kane, Aikin, GSFC	Ionospheres	X
15.26 GI	20	Greece	S	Kane, Aikin, GSFC	Kane, Aikin, GSFC	Eclipse Ionospheres	S
15.27 GI	20	Greece	S	Kane, Aikin, GSFC	Kane, Aikin, GSFC	Eclipse Ionospheres	S
15.28 GI	20	Greece	S	Kane, Aikin, GSFC	Kane, Aikin, GSFC	Eclipse Ionospheres	S
15.29 GI	20	Greece	S	Kane, Aikin, GSFC	Kane, Aikin, GSFC	Eclipse Ionospheres	S
15.30 GI	20	Greece	S	Kane, Aikin, GSFC	Kane, Aikin, GSFC	Eclipse Ionospheres	S
15.31 GI	21	Greece	S	Kane, Aikin, GSFC	Kane, Aikin, GSFC	Ionospheres	S
15.12 GI	Aug. 29	WS	S	Pederson, GSFC	Pederson, GSFC	Ion Density	P
15.11 GI	29	WS	S	Pederson, GSFC	Pederson, GSFC	Ion Density	P

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X–Unsuccessful

**Nike Cajun

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
	1960						
6.01 UI	Mar. 16	FC	S	U. Mich.	Bourdeau, GSFC	Ionosphere	S
3.10 UI	17	FC	X	U. Mich.	Bourdeau, GSFC	Ionosphere	X
6.02 UI	June 15	FC	S	U. Mich.	Bourdeau, GSFC	Ionosphere	S
6.03 UI	Aug. 3	WI	S	U. Mich.	Bourdeau, GSFC	Ionosphere	S
	1961						
6.04 UI	Mar. 26	WI	S	U. Mich.	Bourdeau, GSFC	Ionosphere	S
6.05 UI	Dec. 22	WI	S	U. Mich.	Wright, GSFC	Ionosphere	S
	1963						
4.58 UI	Apr. 3	WI	S	Stanford	Bourdeau, GSFC	Ionosphere	S
4.59 UI	July 10	WI	S	Stanford	Bourdeau, GSFC	Ionosphere	S
	1964						
14.143 UI	Apr. 16	WI	S	U. Ill.	Schardt, HQ	Ionosphere	S
14.144 UI	July 15	WI	S	U. Ill.	Schardt, HQ	Ionosphere	S
14.145 UI	15	WI	S	U. Ill.	Schardt, HQ	Ionospheres	S
14.146 UI	15	WI	S	U. Ill.	Schardt, HQ	Ionospheres	S
14.147 UI	Nov. 10	WI	S	U. Ill.	Schardt, HQ	IQSY Ionosphere	S
14.149 UI	19	WI	S	U. Ill.	Schardt, HQ	IQSY Ionosphere	S
14.148 UI	19	SHIP	S	U. Ill.	Schardt, HQ	IQSY Ionosphere	S
	1965						
8.28 UI	Jan. 13	WI	S	Penn State	Schmerling, HQ	Mother-Daughter Ionospheres	X
14.228 UI	Mar. 20	SHIP	S	U. Ill.	Schmerling, HQ	Ionospheres	S
14.229 UI	23	SHIP	S	U. Ill.	Schmerling, HQ	Ionospheres	X
14.230 UI	Apr. 5	SHIP	S	U. Ill.	Schmerling, HQ	Ionospheres	S
14.231 UI	9	SHIP	S	U. Ill.	Schmerling, HQ	Ionospheres	S
14.232 UI	12	SHIP	S	U. Ill.	Schmerling, HQ	Ionospheres	S
8.29 UI	May 5	WI	S	Penn State	Schmerling, HQ	Mother-Daughter Ionospheres	S
14.245 UI	June 14	WI	S	U. Ill.	Schmerling, HQ	Ionospheres	S
14.246 UI	17	WI	S	U. Ill.	Schmerling, HQ	Ionospheres	S
14.213 UI	Sep. 1	WI	S	SCAS	Schmerling, HQ	Ionospheres	S
14.214 UI	3	WI	S	SCAS	Schmerling, HQ	Ionospheres	X
14.244 UI	15	WI	S	U. Ill.	Schardt, HQ	IQSY Ionospheres	S
8.30 UI	Oct. 5	WI	S	Penn State	Schmerling, HQ	Mother-Daughter Ionospheres	S
8.42 UI	11	WI	X	Penn State	Schmerling, HQ	Mother-Daughter Ionospheres	X
14.247 UI	Dec. 15	WI	S	U. Ill.	Schmerling, HQ	Ionospheres Radio and Physics	S
	1966						
14.248 UI	Jan. 10	WI	S	U. Ill.	Schmerling, HQ	Ionospheres	P
14.76 UI	Apr. 8	WI	S	SCAS	Opp, HQ	Ionospheres	S
14.270 UI	June 14	WI	S	U. Ill.	Schmerling, HQ	Ionospheres	S
14.271 UI	Aug. 24	WI	S	U. Ill.	Schmerling, HQ	Ionospheres	S
14.272 UI	25	WI	S	U. Ill.	Schmerling, HQ	Ionospheres	P
	1963						
14.36 DI	Oct. 7	FC	S	BRL	Bourdeau, GSFC	Ionosphere	P

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
	1964						
14.104 DI	Nov. 5	FC	S	BRL	Bourdeau, GSFC	Ionosphere	S
8.19 DI	5	FC	S	BRL	Bourdeau, GSFC	Ionosphere	S
14.105 DI	7	FC	S	BRL	Bourdeau, GSFC	Ionosphere	S
8.20 DI	7	FC	S	BRL	Bourdeau, GSFC	Ionosphere	S
	1961						
8.15 AI	June 24	WI	S	CRPL/AIL	Jackson, GSFC	Ionosphere	S
8.17 AI	Oct. 14	WI	S	Jackson, GSFC	Jackson, GSFC	Ionosphere	S
	1962						
8.16 AI	Feb. 7	WI	S	Jackson, GSFC	Jackson, GSFC	Ionosphere	X
	1965						
14.215 AI	June 18	WI	S	BuStds	Schmerling, HQ	Ionospheres	X
	1966						
14.216 AI	Apr. 6	WI	S	BuStds	Schmerling, HQ	Ionospheres	P
	1960						
3.12 CI	Aug. 22	WI	X	GCA	Bourdeau, GSFC	Langmuir Probe	X
10.25 CI	Dec. 8	WI	S	GCA	Bourdeau, GSFC	Langmuir Probe	S
	1961						
10.51 CI	Aug. 18	WI	S	GCA	Bourdeau, GSFC	Langmuir Probe	S
10.52 CI	Oct. 27	WI	S	GCA	Bourdeau, GSFC	Langmuir Probe	S
	1962						
10.99 CI	Nov. 7	WI	S	GCA	Bourdeau, GSFC	Ionosphere	S
10.108 CI	30	WI	S	GCA	Bourdeau, GSFC	Ionosphere	S
10.109 CI	Dec. 5	WI	S	GCA	Bourdeau, GSFC	Ionosphere	S
	1963						
14.86 CI	Feb. 27	WI	S	GCA	Bourdeau, GSFC	Ionosphere	S
14.87 CI	Mar. 28	WI	P	GCA	Bourdeau, GSFC	Ionosphere	S
14.88 CI	July 14	FC	P	GCA	Bourdeau, GSFC	Ionosphere	P
14.89 CI	20	FC	X	GCA	Bourdeau, GSFC	Eclipse Ionosphere	X
14.90 CI	20	FC	X	GCA	Bourdeau, GSFC	Eclipse Ionosphere	X
14.91 CI	20	FC	S	GCA	Bourdeau, GSFC	Eclipse Ionosphere	S
14.92 CI	20	FC	S	GCA	Bourdeau, GSFC	Eclipse Ionosphere	S
14.93 CI	20	FC	S	GCA	Bourdeau, GSFC	Eclipse Ionosphere	S
14.94 CI	20	FC	S	GCA	Bourdeau, GSFC	Eclipse Ionosphere	S
	1959						
4.02 II	Sep. 17	FC	S	DRTE	Jackson, GSFC	Ionosphere	S
4.03 II	20	FC	P	DRTE	Jackson, GSFC	Ionosphere	X

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
	1961						
8.13 II	June 15	WI	S	DRTE	Jackson, GSFC	Antenna Test	S
	1962						
4.79 II	Nov. 16	WI	X	Australia	Cartwright, Australia	Ionosphere	X
4.80 II	Dec. 11	WI	X	Australia	Cartwright, Australia	Ionosphere	X
Ferdinand III*	11	NOR	S	Norway	Kane, GSFC	Ionosphere	S
Ferdinand II*	14	NOR	S	Norway	Kane, GSFC	NASA T/M only	S
	1963						
4.96 II	Apr. 12	WI	S	Australia	Cartwright, Australia	VLF	S
4.97 II	May 9	WI	S	Australia	Cartwright, Australia	VLF	S
Ferdinand V*	Sep. 8	NOR	S	Norway	Kane, GSFC	Ionosphere	X
Ferdinand IV**	11	NOR	S	Norway	Kane, GSFC	Ionosphere	S
4.93 II	Oct. 17	WI	S	France	Shea, GSFC	Ionosphere	S
4.94 II	31	WI	S	France	Shea, GSFC	Ionosphere	S
	1964						
Ferdinand VI*	Mar. 12	NOR	S	Norway	Kane, GSFC	Ionosphere	S
Ferdinand VII*	15	NOR	S	Norway	Kane, GSFC	Ionosphere	S
Ferdinand VIII*	19	NOR	S	Norway	Kane, GSFC	Ionosphere	S
Ion 1 64-1*	Dec. 1	ARG	S	Argentina	Bauer, GSFC	Ionosphere	S
Ion 1 64-2*	4	ARG	S	Argentina	Bauer, GSFC	Ionosphere	S
	1965						
15.03 II	Mar. 1	NOR	S	Sweden	Schmerling, HQ	Ionospheres	S
15.04 II	3	NOR	S	Sweden	Schmerling, HQ	Ionospheres	S
Ferdinand IX*	Sep. 7	NOR	S	Norway	Kane, GSFC	Auroral Absorption	X
Ferdinand X*	15	NOR	P	Norway	Kane, GSFC	Auroral Absorption	X
Ferdinand XI*	20	NOR	P	Norway	Kane, GSFC	Auroral Absorption	X
4.138 II	17	WI	S	France	Stevens, GSFC	VLF Experiment	S
14.139 II	25	WI	S	France	Stevens, GSFC	VLF Experiment	S
Ferdinand XII*	Nov. 20	NOR	S	Norway	Kane, GSFC	Ionospheres	S
14.68 II	Dec. 15	BRAZ	S	Brazil	Blumle, GSFC	Ionospheres	S
14.69 II	18	BRAZ	S	Brazil	Blumle, GSFC	Ionospheres	S
	1966						
14.166 II	July 14	WI	S	Germany	Bauer, GSFC	Ionospheres	S
				SOLAR PHYSICS			
	1960						
3.01 GS	Mar. 1	WI	S	Hallam, GSFC	Hallam, GSFC	Solar Study	X
3.02 GS	3	WI	S	Hallam, GSFC	Hallam, GSFC	Solar Study	X
3.03 GS	Apr. 27	WI	X	Hallam, GSFC	Hallam, GSFC	Solar Study	X
3.04 GS	May 25	WI	X	Hallam, GSFC	Hallam, GSFC	Solar Study	X
	1961						
4.25 GS	Sep. 30	WI	S	Behring, GSFC	Behring, GSFC	Solar Studies	S

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*Nike Cajun
**Nike Apache

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
	1963						
4.77 GS	July 20	WI	S	Hallam, GSFC	Hallam-Wolff, GSFC	Solar Studies	X
4.78 GS	Oct. 1	WI	S	Hallam, GSFC	Hallam, GSFC	Solar Studies	P
4.33 GS	15	WI	S	Muney, GSFC	Muney, GSFC	Solar Studies	S
	1964						
4.116 GS	Oct. 30	WI	S	Muney, GSFC	Muney, GSFC	Solar Studies	S
	1965						
4.63 GS	Mar. 17	WS	S	Muney, GSFC	Muney, GSFC	Solar Studies	S
4.49 GS	Apr. 12	WS	S	Fredga, GSFC	Fredga, GSFC	Solar Studies	S
4.53 GS	Oct. 26	WS	S	Fredga, GSFC	Fredga, GSFC	Solar Studies	X
4.145 GS	Dec. 2	WS	S	Fredga, GSFC	Fredga, GSFC	Solar Studies	P
	1966						
4.95 GS	May 20	WS	S	Underwood, GSFC	Underwood, GSFC	Solar X-ray	S
4.92 GS	20	WS	S	Neupert, GSFC	Neupert, GSFC	Solar Spectra	S
	1962						
4.23 US	July 24	WI	S	U. Colo.	Lindsay, GSFC	Sunfollower	P
4.21 US	Nov. 27	WI	S	Harvard	Lindsay, GSFC	Solar	X
	1963						
4.22 US	Sep. 6	WI	S	Harvard	Lindsay, GSFC	Solar Studies	S
	1966						
4.24 US	Apr. 14	WS	S	U. Colo.	Dubin, HQ	Solar Studies	P
	1963						
4.61 AS	June 20	WI	S	NRL	Packer, NRL	Coronograph	P
4.62 AS	28	WI	S	NRL	Packer, NRL	Coronograph	P
	1965						
4.146 DS	Oct. 20	WS	S	NRL	Smith, HQ	1965F Comet Solar Studies	P
	1966						
4.99 DS	Mar. 2	WI	S	AFCRL	Smith, HQ	Solar Studies	S
4.100 DS	3	WI	S	AFCRL	Smith, HQ	Solar Studies	P
4.189 DS	Apr. 28	WS	S	NRL	Smith, HQ	Solar Studies	S
4.101 DS	Aug. 26	WI	S	AFCRL	Schmerling, HQ	Solar Studies	S
				GALACTIC ASTRONOMY			
	1960						
4.40 GG	Apr. 27	WI	P	Kupperian, GSFC	Kupperian, GSFC	Stellar Fluxes	P
4.05 GG	May 27	WI	S	Boggess, GSFC	Boggess, GSFC	Stellar Fluxes	P

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
4.06 GG	June 24	WI	S	Boggess, GSFC	Boggess, GSFC	Stellar Fluxes	S
4.11 GG	Nov. 22	WI	S	Stecher, GSFC	Stecher, GSFC	Stellar Spectra	S
	1961						
4.34 GG	Mar. 31	WI	P	Boggess, GSFC	Boggess, GSFC	Stellar Fluxes	P
9.01 GG	Sep. 18	AUS	S	Boggess, GSFC	Boggess, GSFC	Stellar Photo	S
9.02 GG	Oct. 4	AUS	S	Boggess, GSFC	Boggess, GSFC	Stellar Photo	S
9.03 GG	Nov. 1	AUS	S	Boggess, GSFC	Boggess, GSFC	Stellar Photo	P
9.04 GG	20	AUS	S	Boggess, GSFC	Boggess, GSFC	Stellar Photo	S
	1962						
4.35 GG	Feb. 7	WI	X	Stecher, GSFC	Stecher, GSFC	Stellar Spectra	X
4.36 GG	Sep. 22	WI	S	Stecher, GSFC	Stecher, GSFC	Stellar Photo	S
	1963						
4.30 GG	Mar. 28	WI	S	Boggess, GSFC	Boggess, GSFC	Stellar Spectra	S
4.37 GG	July 19	WI	S	Stecher, GSFC	Stecher, GSFC	Stellar Spectra	S
4.29 GG	23	WI	S	Stecher, GSFC	Stecher, GSFC	Stellar Spectra	S
4.31 GG	Oct. 10	WI	X	Boggess, GSFC	Boggess, GSFC	Stellar Spectra	X
	1964						
4.15 GG	Apr. 3	WI	S	Boggess, GSFC	Boggess, GSFC	Stellar Spectra	X
4.81 GG	10	WI	X	Boggess, GSFC	Boggess, GSFC	Stellar Spectra	X
4.82 GG	Aug. 11	WI	S	Boggess, GSFC	Boggess, GSFC	Stellar Spectra	X
4.126 GG	22	WI	P	Boggess, GSFC	Boggess, GSFC	Stellar Spectra	S
4.109 GG	Nov. 7	WI	S	Stecher, GSFC	Stecher, GSFC	Stellar Spectra	S
4.110 GG	14	WI	S	Stecher, GSFC	Stecher, GSFC	Stellar Spectra	S
	1965						
4.56 GG	Mar. 13	WS	S	Boggess, GSFC	Boggess, GSFC	Stellar Spectra	X
4.57 GG	19	WS	S	Boggess, GSFC	Boggess, GSFC	Stellar Studies	S
4.114 GG	Apr. 24	WS	X	Boggess, GSFC	Boggess, GSFC	Stellar Studies	X
4.89 GG	May 5	WI	S	Boggess, GSFC	Boggess, GSFC	Stellar Studies	X
4.155 GG	Nov. 30	WS	S	Scolnik, GSFC	Scolnik, GSFC	Stellar Spectra	S
	1966						
4.90 GG	Jan. 18	WI	S	Wright, GSFC	Wright, GSFC	Stellar Spectra	X
4.159 GG	July 16	WS	S	Stecher, GSFC	Stecher, GSFC	Stellar Spectra	S
	1962						
4.54 UG	Oct. 30	WI	S	U. Wisc.	Kupperian, GSFC	Stellar Studies	S
	1964						
4.55 UG	Sep. 2	WI	S	U. Wisc.	Kupperian, GSFC	Stellar Studies	S
4.52 UG	Nov. 3	WI	P	Princeton	Kupperian, GSFC	Stellar Spectra	P
	1965						
4.133 UG	Mar. 6	WS	S	Princeton	Kupperian, GSFC	Stellar Spectra	X
4.17 UG	June 2	WS	S	Princeton	Kupperian, GSFC	Stellar Spectra	P
4.151 UG	Oct. 13	WS	S	Princeton	Kupperian, GSFC	Stellar Spectra	S

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
	1966						
4.50 UG	Feb. 2	WS	S	Princeton	Kupperian, GSFC	Stellar Spectra	S
4.171 UG	May 18	WI	S	U. Wisc.	Roman, HQ	Stellar Studies	P
4.51 UG	24	WS	P	Princeton	Kupperian, GSFC	Stellar Spectra	P
	1962						
4.69 CG	Sep. 30	WI	S	Lockheed	Dubin, HQ	Night Sky Mapping	S
	1963						
4.70 CG	Mar. 16	WI	S	Lockheed	Depew, GSFC	Stellar Spectra	S
	1964						
4.122 CG	Aug. 29	WI	S	AS&E	Roman, HQ	Stellar Studies	S
4.120 CG	Oct. 2	WI	S	Lockheed	Roman, HQ	Stellar X-ray	S
4.123 CG	Oct. 27	WI	S	AS&E	Roman, HQ	Stellar Studies	S
	1965						
4.147 CG	Sep. 22	WS	S	AS&E	Roman, HQ	Celestial X-ray	S
4.121 CG	Oct. 1	WS	S	Lockheed	Roman, HQ	Stellar X-ray	S
	1966						
4.148 CG	Mar. 8	WS	S	AS&E	Roman, HQ	Stellar X-ray	S
	1966						
4.144 DG	July 19	WS	P	NRL	Roman, HQ	Stellar	X
				RADIO AND ASTRONOMY			
	1964						
8.33 GR	Oct. 23	WI	S	Stone, GSFC	Stone, GSFC	Radio Astronomy	S
	1965						
14.75 GR	Sep. 9	WI	S	Stone, GSFC	Stone, GSFC	Radio Propagation	S
	1966						
8.44 GR	May 20	WI	S	Stone, GSFC	Stone, GSFC	Radio Astronomy	S
	1962						
11.02 UR	Sep. 22	WI	S	U. Mich.	Roman, HQ	Radio Astronomy	S
	1965						
11.03 UR	June 30	WI	S	U. Mich.	Roman, HQ	Radio Astronomy	S

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING DATE	FIRING SITE	FIRING PERF*	EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
				BIOLOGICAL			
	1961						
11.04 GB	Nov. 15	Pt. A	S	Ames	Smith, HQ	BIOS 1	X
11.05 GB	18	Pt. A	P	Ames	Smith, HQ	BIOS 1	X
				SPECIAL PROJECTS			
	1960						
1.03 GP	Sep. 15	FC	S	Baumann, GSFC	Baumann, GSFC	AMPP	S
1.05 GP	24	FC	S	Baumann, GSFC	Baumann, GSFC	AMPP	P
4.43 GP	Oct. 5	FC	S	NRL	Baumann, GSFC	AMPP	S
	1961						
1.04 GP	May 17	FC	S	Baumann, GSFC	Baumann, GSFC	AMPP	P
1.06 GP	19	FC	S	Baumann, GSFC	Baumann, GSFC	AMPP	S
	1964						
4.13 GP-GT	Sep. 26	WI	S	Busse, GSFC	Busse, GSFC	Multiple piggyback	S
	1961						
4.38 NP	Feb. 5	WI	S	LeRC	Gold, LeRC	Hydrogen Zerog	P
4.39 NP	Apr. 21	WI	S	LeRC	Gold, LeRC	Hydrogen Zerog	S
4.42 NP	Aug. 12	WI	S	LeRC	Plohr, LeRC	Hydrogen Zerog	P
4.40 NP	Oct. 18	WI	S	LeRC	Regetz, LeRC	Hydrogen Zerog	S
	1962						
4.41 NP	Feb. 17	WI	S	LeRC	Dillon, LeRC	Hydrogen Zerog	S
4.46 NP	May 8	WI	P	JPL	Brown, JPL	Radar	X
4.26 NP	June 20	WI	S	LeRC	Flagge, LeRC	Hydrogen Zerog	P
4.47 NP	July 10	WI	S	JPL	Brown, JPL	Radar	X
4.27 NP	Nov. 18	WI	S	LeRC	Corpas, LeRC	Hydrogen Zerog	S
	1963						
4.66 NP	May 14	WI	S	LaRC	Kinard, LaRC	Paraglider	X
4.28 NP	June 19	WI	S	LeRC	Corpas, LeRC	Hydrogen Zerog	P
4.32 NP	Sep. 11	WI	S	LeRC	Corpas, LeRC	Hydrogen Zerog	S
	1964						
4.67 NP	June 10	WI	S	LaRC	Kinard, LaRC	Paraglider	S
	1965						
4.105 NP	June 30	WS	S	JPL	Gaugler, HQ	High Altitude Radar	X
	1966						
4.106 NP	May 9	WS	S	JPL	Gaugler, HQ	High Altitude Radar	S

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PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
	1962						
4.71 UP	June 29	WI	S	JHU	Depew, GSFC	Airglow	S
4.72 UP	29	WI	S	JHU	Depew, GSFC	Airglow	S
				TEST AND SUPPORT			
	1959						
2.01 GT	May 14	WI	X	Medrow, GSFC	Medrow, GSFC	Rocket Test	S
2.02 GT	15	WI	X	Medrow, GSFC	Medrow, GSFC	Rocket Test	S
2.03 GT	15	WI	X	Medrow, GSFC	Medrow, GSFC	Rocket Test	X
2.04 GT	Aug. 7	WI	X	Medrow, GSFC	Medrow, GSFC	Rocket Test	X
2.05 GT	7	WI	X	Medrow, GSFC	Medrow, GSFC	Rocket Test	X
2.06 GT	7	WI	X	Medrow, GSFC	Medrow, GSFC	Rocket Test	S
8.01 GT	Dec. 22	WI	S	GSFC/NRL/DRTE	Winkler, GSFC	X248 Vibration Test	S
	1960						
8.02 GT	Jan. 26	WI	S	GSFC/NRL/DRTE	Winkler, GSFC	X248 Vibration Test	S
4.01 GT	Feb. 16	WI	X	Medrow, GSFC	Medrow, GSFC	Rocket Test	X
4.12 GT	Mar. 25	WI	S	Medrow, GSFC	Medrow, GSFC	Rocket Test	S
4.10 GT	Apr. 23	WI	S	Medrow, GSFC	Medrow, GSFC	Rocket Test	S
5.01 GT	July 22	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Test	S
3.28 GT	Aug. 9	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Test	S
5.02 GT	Oct. 18	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Test	S
3.29 GT	Nov. 3	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Test	S
	1961						
3.36 GT	Jan. 17	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Test	S
5.03 GT	19	WI	X	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Test	P
10.49 GT	Mar. 15	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Cajun Fin Test	S
4.19 GT	Apr. 14	WI	S	Russell, GSFC	Russell, GSFC	Attitude Control	P
12.01 GT	May 2	WI	S	U. Mich.	Spencer, GSFC	Cone Test	S
14.01 GT	25	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Test	S
4.20 GT	June 26	WI	S	Russell, GSFC	Russell, GSFC	Attitude Control	P
14.02 GT	Aug. 16	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Test	S
	1962						
4.68 GT	Jan. 13	WI	S	Russell, GSFC	Russell, GSFC	Attitude Control	S
10.69 GT	Mar. 1	WI	X	Donn, GSFC	Donn, GSFC	Water Launch	S
10.70 GT	2	WI	S	Donn, GSFC	Donn, GSFC	Water Launch	S
4.48 GT	May 25	WI	S	Pressly, GSFC	Pressly, GSFC	Sea Recovery	S
4.60 GT	Aug. 8	WI	P	Russell, GSFC	Russell, GSFC	Attitude Control	P
	1963						
16.01 GT	Apr. 8	WI	X	Sorgnit, GSFC	Sorgnit, GSFC	ACS Test	X
4.87 GT	June 17	WI	S	Russell, GSFC	Russell, GSFC	Attitude Control	S
14.111 GT	Oct. 31	WI	S	Williams, GSFC	Williams, GSFC	Vibration Test	S
	1964						
4.88 GT	Jan. 28	WI	S	Russell, GSFC	Russell, GSFC	Attitude Control	S
14.28 GT	Feb. 12	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Fin Test	S

* S–Successful
P–Partial Success } – – Subject to Interpretation
X–Unsuccessful

PART III
NASA SOUNDING ROCKET FLIGHTS (Cont.)

NASA NO.	FIRING			EXPERIMENTER	NASA SCIENTIST AND LOCATION	EXPERIMENT	RESULTS*
	DATE	SITE	PERF*				
12.03 GT	Apr. 15	WI	S	Guidotti, GSFC	Guidotti, GSFC	Rocket Test	S
4.13 GT	Sep. 26	WI	S	Busse, GSFC	Busse, GSFC	Rocket Test	S
16.02 GT	Oct. 21	WI	S	Sorgnit, GSFC	Sorgnit, GSFC	Rocket Test	S
12.02 GT	Dec. 11	WI	S	Lane, GSFC	Lane, GSFC	Rocket Test	S
	1965						
17.01 GT	June 18	WI	S	Lane, GSFC	Lane, GSFC	Rocket Test	S
	1966						
17.02 GT	Aug. 17	WI	S	Lane, GSFC	Lane, GSFC	Rocket Test	S

NUMBER OF VEHICLES FIRED 1959 - JUNE 1966

AEROBEE 100	14	JAVELIN	34
ARCON	6	SKYLARK	4
NIKE ASP	27	NIKE CAJUN	211
AEROBEE 150	76	JOURNEYMAN	7
AEROBEE 150A	67	SPECIAL	3
IRIS	4	NIKE APACHE	242
AEROBEE 300/300A	11	ASTROBEE 1500	2
AEROBEE 350	1	NIKE TOMAHAWK	5
ARCAS	20		

*S–Successful
P–Partial Success } - - Subject to Interpretation
X–Unsuccessful

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